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Learning Technology Specification: Principles for Army Training Designers and Developers

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14. ABSTRACT *(Maximum 200 words)*:
To achieve the technology goals for the Army Learning Model (ALM), there is a need for a set of guidelines that will support training designers and developers in identifying and effectively incorporating new learning technologies into training. Such technology specification guidelines and principles must support the goals of the ALM by taking into account technology effectiveness for training across various environments, ranging from traditional schoolhouse courses to more dynamic operational environments. Thus, Army training development must include a process to support the selection of learning technology that is compatible with the training environment, pedagogically appropriate, and cost effective. This report describes the development of a principled technology specification process that enables training developers to comprehensively consider various aspects of training. The process, driven both by sound scientific principles on how best to integrate technology into training and operational reality, contains three main factors: Learning Requirements, Technology Attributes, and Resources and Constraints. The process guides the user through considerations within each of those factors to facilitate critical thinking about the technology so that it will best meet learning needs within the ALM.

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LEARNING TECHNOLOGY SPECIFICATION: PRINCIPLES FOR ARMY TRAINING DESIGNERS AND DEVELOPERS

EXECUTIVE SUMMARY

Research Requirement:

To achieve the technology goals for the Army Learning Model (ALM), there is a need for comprehensive guidelines that assist training designers and developers in identifying and incorporating new technologies. Army training development must include a process to support the selection of learning technology that is compatible with the training environment, pedagogically appropriate, and cost effective. Therefore, a principled technology specification process was developed that will enable training developers to critically consider various aspects of training such as the learner, learning objectives, and constraints and to take advantage of technological capabilities that can make learning more operationally relevant, engaging, individually tailored, cost-effective, and accessible across all domains of Army training.

Procedure:

To develop a process that guides technology specification decisions, current selection principles were identified and examined. Information obtained from a review of the academic literature, as well as interviews at three Army training centers revealed the following factors to be instrumental in the development of a learning technology specification process: 1) factors that influence the training effectiveness of technology; 2) considerations that training designers and developers take into account before selecting technology; and 3) potential constraints and opportunities for applying the factors, considerations, and selection principles to Army training development activities. The most critical principles and considerations were aggregated to develop guidance for making the most effective technology specification decisions within the constraints of limited resources.

Findings:

A set of principled technology specification guidelines was developed to enable training designers and developers to think critically about the required capabilities of learning technology for supporting training objectives. The process by which those guidelines are presented comprises three matrices that promote critical thinking about three important aspects of training: *Learning Requirements*, *Technology Capabilities*, and *Resources and Constraints*. Each matrix contains a set of questions that address those important aspects of training, and designers and developers select from among three possible responses that best describes their training objectives. The outcome of this process yields a set of critical technology requirements that enable designers and developers to select or develop the most appropriate learning technology for training.

Utilization and Dissemination of Findings:

The learning technology specification process was briefed to the Fires Center of Excellence Directorate of Training and Doctrine in March of 2013. The process fits within the Design phase of the Army's instructional system design process: the user must first complete the steps in the Analyze phase (i.e., identify the training objectives, training audience, training location, and other relevant information) in order to effectively use the technology specification process. The factors and considerations that serve to guide the user through the process are generalizable across Army training development, yet identify critical constraints for incorporating technologies into training. Training designers and developers can use this process to make more efficient and effective technology decisions.

LEARNING TECHNOLOGY SPECIFICATION: PRINCIPLES FOR ARMY TRAINING DESIGNERS AND DEVELOPERS

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"The 21st Century Army training and education development programs and initiatives must prepare Soldiers, units, and Army civilians to rapidly adapt to complex situations across the FSO [Full Spectrum Operations], to fight when necessary, and to win decisively" (U.S. Army Training and Doctrine Command, 2011, p. 20).

Introduction

The military is embarking into a time when all personnel must be prepared to quickly succeed within dynamic, complex situations. That demand for complex skill sets to be executed in a variety of environments has posed training challenges for the Army and other services. As illustrated by the opening quote from Training and Doctrine Command (TRADOC) Regulation 350-70, training programs must adapt to help the warfighter succeed within today's challenging environment. One change that the military has implemented is to make more frequent use of technology in training. Although the Army has not strayed from its three domains of learning (operational, institutional, and self-development), there has been a demand to use blended learning approaches within each domain to better prepare Soldiers for FSO (TRADOC, 2011). With that blended learning approach comes a necessary focus on the use of technology for learning.

Over the last several decades, technology has made its way into almost every aspect of life. The focus on technology holds true particularly in learning contexts, and there is a large body of literature that documents the ways in which instructors have sought to integrate technologies into their pedagogical approaches. The military's adherence to that trend is typified by the Army Learning Model (ALM) for 2015 (Department of the Army, 2011), which emphasizes adapting current learning models to include technology-related considerations. The potential benefits of doing so include lowered training costs, more engaging and immersive learning experiences, and the potential for mobile (anytime and anywhere) learning.

Currently, training is characterized as "instructor-led slide presentation lectures" in the classroom (Department of the Army, 2011, p.16). The Army is focusing on technology as a way to enable learning to be operationally relevant, engaging, individually tailored, and accessible. One caveat is that the specification of technology must not be haphazard. The academic literature states that all technology is not equal, and more high-tech solutions do not always produce better learning outcomes. Therefore trainers and instructional designers must carefully consider the strengths and weaknesses associated with any approach (cf. Dalgarno & Lee, 2010). To integrate technology into the Army's training programs, a set of learning technology specification guidelines is needed to guide technology choices so that they align with training objectives.

The general term “guidelines” is used instead of a more specific term such as “rules” or “principles” because the end product of this effort is intended to be an eclectic compilation of “what works.” Although it is an important distinction in other venues, no distinction in this work is made between what Clark & Estes (1998) have termed “educational craft” and “educational technology” – both are subsumed into “technology.”

Current Research Approach

The goal of the current research was to develop a process to help training designers and developers make informed decisions with regard to technology specification. The process guides the user through a series of steps to select learning technologies that most effectively fit with their learning and training objectives as well as their available resources/constraints. The outcome is a set of technology requirements from which training selection and development decisions can be made.

A two-pronged approach was taken. First, the academic literature was reviewed to understand the principles for selecting the most effective training technology. The literature review served as a theoretical foundation for the process. Second, input from active duty Army training designers and developers was obtained in order to ensure that the process was grounded in current operations. Interviews were conducted at three different Army installations to determine how technology is selected and used for training. The interview findings were combined with literature review findings to create a usable process that has scientific backing.

This report describes the technology specification process that was developed, as well as the method used to develop it. It begins with a discussion of the literature, followed by the data collection methodology. The results of the literature review and interviews are then discussed and integrated, and the final process is presented with a discussion of how to use the process as well as the implications for doing so. Finally, an outline for a course that instructs training designers and developers on how to use the learning technology specification process is included in draft Training Support Package (TSP) format.

Technology Specification Principles in the Literature

The purpose of the literature review was to identify technology specification principles that may be relevant to the Army. The review focused on when to integrate technology into the training process, and which technology characteristics align well with the various methods of content delivery. The review also identified emerging learning technologies and extracted characteristics of those technologies that are most conducive to learning. The literature review included scholarly publications, peer-reviewed journals, industry periodicals, and doctoral dissertations in the fields of cognitive psychology, educational psychology, information systems, and instructional design. By synthesizing those different areas and integrating the lessons learned from each, a theoretically justified foundation was established from which a unified set of technology specification guidelines can be designed for use in Army training programs. A detailed summary of all the reviewed items is at Appendix A.

Literature Overview

The academic literature indicates that a holistic, nuanced approach must be used to most effectively integrate educational technology. Despite the evolution of ever more elaborate, higher fidelity technology, incorporating more technology into an instructional design does not always guarantee better learning outcomes (Bedwell & Salas, 2010; Moreno & Mayer, 2007; Salas, 2006). Instead, the developer must carefully consider the use of technology both from a pedagogical and technology affordance perspective, and this must be done specifically in the context of the particular learning environment in which it will be used. According to Bower (2008), an affordance is a characteristic of the technology that provides an experience through which learning takes place. For example, Bower describes media affordances which characterize the "read-ability" and "write-ability" of a technology that determine how easy it is for a student to read and write content using that technology.

Once the decision to incorporate technology has been made, the next step is to select the most appropriate type of technology. Selection can be guided by cognitive psychology principles to understand how the affordances offered by a particular technology promote the desired learning objectives (e.g., Li, Santhanam, & Carswell, 2009; Moreno, 2005), as well as more practical considerations, such as the training audience and the learning environment.

Integrating Technology into Training

All instruction, regardless of the learning objectives, can be thought of as the process of transforming knowledge into a form that can be effectively conveyed to the learner (Shulman, 1987). Instructional design has the essential function of determining the most relevant and useful method for delivering this knowledge, given the learning objectives. In traditional pedagogical theory, instructors must consider beliefs, ideas, their own knowledge state, and the learners' knowledge states when structuring their lessons (Entwistle, 1987; Shulman, 1987). Depending on the learners' initial knowledge base, instructors may need to reconfigure their lesson plans to keep the learners engaged, adjusting as needed throughout the course to compensate for varying levels of ability (Shulman, 1987). To make the necessary adjustments to course details, there must be a firm understanding of the specific learning-related attributes associated with different instructional methods. In the realm of traditional educational design, that knowledge is conventionalized; however, as emerging technologies introduce new possibilities, the picture becomes much more uncertain.

If training designers and developers want to integrate technology into their courses, they must understand the particular affordances of that technology. For example, if training objectives are focused on spatial relationships, technology such as animations can emphasize relationships between actors and enhance spatial learning processes far better than traditional text-based representations (Li et al., 2009). Affordances are not strictly inherent to technology; the manner in which a technology is presented can have a large impact on which affordances are realized (Koehler, Mishra, & Yahya 2005; Krauskopf, Zahn, & Hesse, 2012; Webb & Cox, 2004). Therefore, when considering whether or not to use technology in training, designers and developers must first consider what benefits a technology can provide over more traditional

learning aids, and then determine the best way to integrate and use that technology within a specific training session.

An additional consideration is the extent to which instructors are able to effectively use the technology. One construct that represents this ability is called technological pedagogical content knowledge (TPCK; Mishra & Koehler, 2006). TPCK refers to "knowledge about how external representations and digital technologies can specifically support conceptual understanding in a specific subject by combining it with a certain task and adequate instructional guidance." (Krauskopf et al., 2012, p. 1195). An instructor's level of TPCK is determined by pedagogical knowledge, knowledge of the course objectives and content, and proficiency using the technology (Mishra & Koehler, 2006). The notion of TPCK is nonetheless helpful in emphasizing the importance of appropriately educating the instructor about the potential uses of technology in the educational context.

From this discussion, several principles can be derived for incorporating technology into the learning process. The more cogent of these principles are:

- Incorporating more technology into an instructional design does not always guarantee better learning outcomes (Bedwell & Salas, 2010; Moreno & Mayer, 2007; Salas, 2006).
- Technology benefits must be considered in the context of the particular learning environment in which it will be used (Bower, 2008; Webb & Cox, 2004).
- The manner in which a technology is presented and used by learners impacts how the technology can be used to promote learning (Bower, 2008).
- Properly educated instructors can make better use of technology for learning (Angeli & Valanides, 2005, 2009; Krauskopf et al., 2012 Mishra & Koehler, 2006).

Choosing the Most Appropriate Technology

Once the decision to use technology has been made, there are several considerations for choosing the most appropriate technology. Two of the most critical considerations are 1) how can the technology can be used to promote learning objectives, and 2) what are the relevant characteristics of the training audience and environment. Those considerations will be discussed in the subsequent sections.

Assessing technology: learning objectives and cognitive processing. One of the most common methods for selecting technology is to consider the specific affordances that it must provide. However, while there is some agreement as to which affordances map to what technologies, there has historically been no standardized process for how to conduct an affordance analysis (Moreno & Mayer, 2007; Wilson et al, 2008). Bower (2008) provides a general framework for the process by using an example of technology selection for an online graduate student course to illustrate the necessary steps and considerations. The affordance analysis occurs during a three-step technology selection process. The first step is explicitly identifying the educational goals for the course, which in Bower's example were both to facilitate understanding of concepts and to apply that knowledge to a specific situation. Based on those goals, the second step involves identifying suitable tasks that will foster the desired learning. For example, tasks encouraging basic understanding can include stimulating students

with questions addressing declarative knowledge integrated with an evaluative component to aid self-reflection; similarly, the goal of application would be better suited to hands-on tasks where students must create products or complete routines.

Once the learning tasks are identified, the final step is the affordance analysis of both the learning tasks and the potential learning technologies under consideration. Bower (2008) provides a sample 11-category affordance taxonomy which includes factors such as media, temporal, navigation, and synthesis affordances. Within each affordance, subcategories can be created; for example, media affordances could be divided into read-ability, view-ability, and listen-ability. Affordances are matched with tasks based on the importance of that affordance to that task (e.g., "move-ability" is useful for being able to represent relationships between the different types of declarative knowledge in the course, while "synchronous-ability" is important when group interaction is required). The technology affordance analysis happens at the same time for each candidate technology. In Bower's example, in comparing online discussion boards to virtual classrooms, both shared the "write-ability" affordance, but only the virtual classroom had the "synchronous-ability" affordance. Once the affordances have been decomposed, the final step is to compare the fit between the affordances needed to accomplish the learning objective and the affordances provided by candidate technologies, ultimately selecting the technology with the best fit and within the resource constraints. Note that the optimal technology is not simply the one with the *most overall* affordances; rather, it will be the one that most directly matches up with the necessary affordances of the tasks needed to foster the desired learning goals.

Going one step beyond considering learning objectives, when deciding what type of technology to integrate into a training activity, it is also important to examine the cognitive processes involved in learning. Several learning theories provide background information on how to select technology to promote effective cognitive processing. For various types of visual multimedia, the theory of anchored instruction provides a theoretical basis for the benefits of incorporating such technology into the lesson plan (Kong, 2011; Thomas, 2012). On the other hand, cognitive fit theory focuses on more specific affordances of contrasting technologies and how particular affordances are most conducive to a particular set of cognitive processes (Li et al., 2009). Finally, the Cognitive Affective Theory of Learning with Media (CATLM) (Moreno, 2005) provides a general framework for understanding cognitive load (cf. Sweller, 1988) and what can be done to minimize extraneous cognitive demands in training. As outlined below, such theories were useful to the development of the process by providing the principles by which to link the various technology types to learning requirements.

The driving force behind the effectiveness of anchored instruction and the related concepts of situated learning is the pedagogical principle that anchoring learning in a meaningful context for the students is essential for effective instruction (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Cannon-Bowers & Bowers, 2010). When those anchored environments are created in the classroom, students are able to connect new knowledge to what they already know to help them understand complex novel information, thereby fostering richer and memorable learning (Cannon-Bowers & Bowers, 2010). Simulated and virtual learning environments (SLEs/VLEs) and computer games are able to leverage this principle by immersing learners into contexts they have experience with, and guide development of the specific skills

desired within those contexts. Benefits of such technologies include a lower cost than creating real-life exercises, creating opportunities to try and fail repeatedly without repercussions (e.g., crashing a plane in a flight simulator), and intrinsic motivation for engaging in learning due to novelty or "fun factor" (Antes & Schulke, 2011; Cannon-Bowers & Bowers, 2010; Dalgarno & Lee, 2010; Wilson et al, 2008). However, it is important to note that less costly, traditional multimedia technology may also be used to create effective situated learning environments, depending on the learning objectives and learner characteristics. Simple computer games, video presentations, and interactive PowerPoint presentations can all be leveraged to enhance traditional learning techniques when designed appropriately (Gill, 2007; Kong, 2011; Thomas, 2012).

Cognitive fit theory explains why some technologies are more conducive to particular learning objectives than others. Depending on the knowledge or skills to be trained, greater emphasis should be placed on the learning experience that will yield the most effective educational process (Bedwell & Salas, 2010). For example, one consideration is whether the objective is focused more on information acquisition (e.g., learning what something is) or response strengthening (e.g., what to do in a given situation). In the former case, the training emphasis should be placed on presenting detailed stimulus material and providing learning guidance, both of which can be easily accomplished through videos and lecture formats (Bedwell & Salas, 2010). However, in the case of response strengthening, initiating recall of past learning and eliciting performance are most important and are prominent affordances in game or simulation-type technologies (Bedwell & Salas, 2010; Cannon-Bowers & Bowers, 2010). Similarly, any type of animation-based technology has the benefit of making motions and interaction between different agents very salient, thereby lending them to enhancing spatial learning or procedural knowledge related objectives (Li et al., 2009). However, the benefits of animation are of limited use in more declarative knowledge objectives.

One of the most common cautions in the learning technology literature is that more elaborate technology solutions (e.g., higher fidelity, more interactivity) are not always better and can even hurt learning (Bedwell et al., 2010; Dobbs, 2006; Salas, 2006; Wieling & Hoffman, 2010). A reason for the potential negative effects can be found in the CATLM and the role of cognitive workload (Moreno, 2005). That theory centers on the fact that people have a finite amount of cognitive resources available to them, and that those resources must be allocated between interpreting incoming stimuli across multiple modalities (e.g., auditory, visual), synthesizing the information (i.e., creating a working mental model of the situation), and creating new connections (i.e., solidifying the information or skill learned). To free up the most resources for learning, one must reduce the cognitive load of the training material. Because cognitive load increases with the number of different information modalities used, one strategy to minimize load is to use technology that relies only on the modalities most relevant to the training objective. If one is imparting declarative knowledge, an animated video of a talking character will be more distracting and less effective than a simple audio or text presentation (Li et al., 2009). Similarly, the added complexity of stimulation requires more cognitive resources to attune to the added details, so it is important to use a degree of complexity most appropriate for learner experience level (Dror, 2011). Distributing the training content across complementary modalities can sometimes be beneficial, depending on the training characteristics. For example, when complexity of the training is essential, it is more efficient to have a large cognitive load spread

across modalities than it is to have one overloaded modality (Moreno & Mayer, 2007). Haptic simulators have taken advantage of this quality, finding that incorporating tactile learning enhances both physical skill performance and spatial knowledge as compared to non-haptic simulations (San Diego et al., 2012, Shönborn, Bivall, & Tibell, 2011).

The literature described in this section results in several principles to be incorporated into a learning technology specification process. Some of these principles are:

- To fit technology into training, instructors should focus on identifying the cognitive requirements of the learning objective in tandem with the specific affordances of technologies (Bower, 2008).
- Depending on the knowledge or skills to be trained, greater emphasis should be placed on the learning experience that will yield the most effective educational process (Bedwell & Salas, 2010).
- To minimize cognitive load, use technology that relies only on the modalities most relevant to the training objective (Li et al., 2009; Moreno, 2005; Moreno & Mayer, 2007).

The training audience and environment. There are a number of other practical considerations that must also be accounted for in order to maximize learning effectiveness. Two of those other factors are the training audience and the training environment.

Research has demonstrated that learner characteristics are an important factor to consider when selecting any training methodology. With respect to simulators and other high-fidelity technology, an important consideration for selecting the most appropriate technology is learner experience level (Dalgarno & Lee, 2010; Salas, 2006; San Diego et al., 2012). For less experienced learners, low-fidelity approaches have proven to be at least as effective as more costly, higher-fidelity techniques (Salas, 2006). That finding is especially true when initially training complex skills; for example, low-fidelity devices can increase the transfer of trained skills for flight school cadets (Gopher, Weil, & Bareket, 1994). When designing a haptic simulator for training dental school students to drill teeth, San Diego et al. (2012) specifically considered student expertise, noting that high fidelity simulation would be unnecessary for first year students. As a result, the haptic simulator was implemented solely for training more advanced students.

In addition to level of expertise, learners' backgrounds and interest in the course material are also important considerations. When training highly technical skills or teaching topics in which students may not take an interest, engagement can be a problem (Watkins & Hufnagel, 2007). To circumvent this, interactive technologies should be used to increase student motivation, which increases learning (Cannon-Bowers & Bowers, 2010; Moreno, 2006; Shönborn et al., 2011). Immersive, interactive technology, such as SLEs and computer games enable personalized and more meaningful experiences, and may lead to increased engagement, learning, and transfer (Cannon-Bowers & Bowers, 2010; Mikropoulos & Natsis, 2009). Less expensive technology, such as online training supplements, or integrating videos into PowerPoint slides, can also increase engagement, but only if the key requirements are met. First, if online supplemental activities are provided, linking them to an assessment with feedback is crucial to

motivating students to engage in the training (Dror, 2011; Watkins & Hufnagel, 2007). Second, although incorporating videos can support understanding, particularly for learning procedural knowledge, a potential danger is that learners may perceive the instructor as distant and uninvolved (Gill, 2007; Watkins & Hufnagel, 2007). As a result, the instructor should take special care to adjust the course in real-time to ensure that learners remain engaged (Gill, 2007).

It can be seen that learner characteristics are an important consideration for selecting the most effective technology. Although the process developed in this research effort does not specifically examine the characteristics of the training audience, it is expected that the user will enter the process having already conducted this analysis (cf. U.S. Army Training and Doctrine Command, 2011), and that he or she thoroughly understands the needs of the training audience.

A final consideration is the practical constraints of the learning environment, which include cost, class size, and technical/administrative support, among others. For example, when designing haptic simulators for a dental school curriculum, one consideration is the number of simulators available for training to accommodate the class size (San Diego et al., 2012). Such constraints may force training developers to revise the course plan for using the simulators during training. With respect to cost constraints, Bedwell and Salas (2010) provide a holistic example of cost-benefit analysis, emphasizing that the training budget should not be the largest factor in the decision to integrate technology into training; rather, one must carefully consider the cost-benefit analysis for using a particular technology. For example, less sophisticated technology may work just as well as more sophisticated technology with declarative knowledge-based learning objectives. The literature suggests that traditional lecture-based formats are at least as equally effective as videos or recordings (Bedwell & Salas, 2010; O'Bannon et al., 2011; Wieling & Hoffman, 2010; Wilson et al., 2008). However, when the learning objectives focus on higher order skills, more sophisticated technology may be required (Dalgarno & Lee, 2010; Talbot, 2012). Before investing in technology, it is important to consider feasibility and affordances provided by candidate technology. Therefore, the process of understanding the resources and constraints associated with the training is the last step in the process.

This literature review resulted in the following technology specification principles that should be incorporated into any technology specification process:

- To maximize learning effectiveness when incorporating technology into training, modify technology characteristics based on trainee characteristics, learning objectives, and environmental constraints (Dalgarno & Lee, 2010; Salas, 2006; San Diego et al., 2012).
- Consider trainee experience level when selecting high-fidelity technologies (Dalgarno & Lee, 2010; Salas, 2006; San Diego et al., 2012).
- Consider trainees' backgrounds and expected interest in course material when selecting technology (Cannon-Bowers & Bowers, 2010; Moreno, 2006; Shönborn, 2011; Watkins & Hufnagel, 2007).
- Interactive technologies can help maintain student engagement when training highly technical skills or teaching less interesting topics (Cannon-Bowers & Bowers, 2010; Moreno, 2006; Shönborn, 2011).
- Personalized experiences, such as those created by immersive, interactive technology, may lead to increased trainee engagement in the exercise, which has been shown to

- promote learning and knowledge transfer (Cannon-Bowers & Bowers, 2010; Mikropoulos & Natsis, 2009).
- The size of the training audience may impose limitations on the presentation method and technology (San Diego et al., 2012).
- Technology must have characteristics that allow it to be used effectively in the domain for which it is intended (Bower, 2008).

Literature Summary

The literature review provided the foundation for developing a process to aid training designers and developers in selecting the most effective technologies. The process developed for this research effort was grounded in several ideas obtained from the literature. First, the literature highlighted the importance of matching learning objectives to technology. Integrating technology for technology's sake is not an effective method that will yield large benefits. Instead, training designers and developers must be aware of what they are trying to train and match the technology's affordances to those objectives. Second, beyond general learning objectives, understanding the cognitive processing that underlies learning is also important. The integration of technology into training can inhibit or facilitate learning, and training designers must carefully consider how technology could potentially inhibit learning. Finally, the literature review provided information about resources and constraints that must be contained within any technology specification process so as to be comprehensive. Such information serves as an important part of the process and should not be overlooked.

The technology specification principles highlighted above can be grouped into the following four general categories:

- Consider the learning requirements (e.g., to fit technology into training, instructors should focus on identifying the cognitive requirements of the learning objective in tandem with the specific affordances of technologies (Bower, 2008)).
- Consider the technology attributes (e.g., to minimize cognitive load, use technology that relies only on the modalities most relevant to the training objective (Li et al., 2009; Moreno, 2005; Moreno & Mayer, 2007)).
- Consider the training audience (e.g., consider trainees' backgrounds and expected interest in course material when selecting technology (Cannon-Bowers & Bowers, 2010; Moreno, 2006; Shönborn, 2011; Watkins & Hufnagel, 2007)).
- Consider the learning environment (e.g., the size of the training course may impose limitations on the presentation method and technology (San Diego et al., 2012)).

The four principles drove the remainder of the analysis and process development, and also provided a foundation for the interview protocol, which is described in the next section.

Current Army Selection Processes

In addition to surveying the relevant literature, the research team surveyed current Army processes to identify the principles that are currently used by the Army training to select learning

technologies. To accomplish this objective, the team interviewed training designers, developers, instructors, and other key training personnel at three different Army bases.

Interview Questions and Survey

The interview questions were developed based on the literature review, as well as information that members of the research team gathered through relevant past experiences with Army training. To consider multiple perspectives, two sets of questions were devised: one intended for training designers and developers and the other for instructors (see Appendix B). The two sets of questions were very similar in nature, but differed in that the questions for the instructors were focused more on the ways in which they use and can benefit from technology, and whether they were part of the selection decision process. The designer and developer questions were focused more on the ways in which they decide which technologies to use, and the considerations that they take into account during the decision making process.

In addition to the interview questions, the project team developed the *Technology Factors Survey* (see Appendix C) to identify which factors are most important to consider in the decision to incorporate technology in training. The factors included in the survey (e.g., familiarity with particular technologies, supportive organizational climate, cost of the technology) were largely based on the literature review findings. Interview participants rated each factor on a scale of 1 (*not at all important*) to 5 (*very important*), and also had the opportunity to list other factors they considered at the bottom of the survey.

Sites and Participants

The project team visited three different Army training centers: Fort Sill in July, 2012; Fort Huachuca in August, 2012; and Fort Lee in September, 2012. Those three sites were chosen because they represent installations with ongoing investment in the use of technology in training. In addition, those sites represent three different job areas: Fires, Military Intelligence, and Support and Sustainment. In total, 26 individuals were interviewed to obtain information about the processes and procedures used for selecting and integrating training technologies.

The interviewees worked in various positions related to training. At Fort Sill, eight individuals (e.g., instructional systems specialists, training specialists, training developers, and instructors) from the Directorate of Training and Doctrine (DoTD) were interviewed over the course of two days. The majority of the interviews were conducted one-on-one, with the exception of one interview, which included two members. No Air Defense Artillery training developers were available at the time of the interviews; only Field Artillery respondents were interviewed. At Fort Huachuca, twelve individuals (e.g., project managers, instructors, training specialists, instructional designers, information technology architects, and instructional systems specialists) were interviewed over the course of one day. Similarly, the majority of the interviews were conducted one-on-one, but two of the interviews consisted of two members. At Fort Lee, four individuals (e.g., training developers) were interviewed.

Protocol

Before each interview began, the interviewers introduced themselves and described the goals of the interviews. Next, the interviewers asked the participants to carefully read the Institutional Review Board (IRB) Privacy Act Statement and sign the Informed Consent Form. Upon completion, the interviewers began the semi-structured interview with an open-ended request for participants to discuss and walk through the processes that they use for selecting learning technologies, as well as any considerations that they felt were important to the process. As they described their approach, the research team asked clarifying questions, as appropriate. The Technology Factors Survey was also administered to the participants at an appropriate time (see Appendix D) in the interview. Participants were encouraged to include factors that they considered important, but were not explicitly mentioned in the survey. Upon concluding the interview, the interviewees were thanked for their time and participation.

The notes taken during the data collection sessions and the completed surveys were reviewed and analyzed to determine the similarities and differences across the Army training centers, as well as for the considerations that participants at each site believed to be critical when selecting learning technology. The interview results were analyzed in tandem with the principles and considerations identified in the academic and educational literature to determine the applicability of the principles to a technology specification process. The outcomes of those analyses were then used for process development.

Relevant Organizational Commonalities and Differences among Training Centers

Subsequent to the interviews at each of the three training centers, similarities and differences across the sites emerged. All three centers follow the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) process; the main activities from each site are highlighted in Table 1. However, each site structures and implements those processes somewhat differently. At Fort Huachuca, the Learning Innovation Office (LIO) employs dedicated project managers (which is unique to this training center), a dedicated software and hardware development group, and dedicated Instructional Systems Design (ISD) professionals to develop or select the most appropriate learning technologies. At Fort Lee, the Technology Innovation Office (TIO) comprises a smaller group of project managers, developers, and ISD professionals working together to develop a narrower group of technologies, such as mobile applications, games and simulations, and to repurpose existing technology solutions to fit the learning requirements. Fort Sill is divided into various branches, including the Analysis Branch, Design Branch, and Development Branch (the names of these branches have changed since the interviews were completed).

Table 1
Technology Specification Activities by Location

	Fort Sill	Fort Huachuca	Fort Lee
Analyze	WHO: Members of the Analysis Branch of DoTD WHAT: Survey units to determine proficiency of new Soldiers and rank potential training solutions	WHO: Training Design and Development Team WHAT: Meet with customer to brainstorm, capture requirements; determine true training gaps and needs; demonstrate proof of concept	WHO: Technology Branch Chief WHAT: Meet with customer or requestor SME to develop ideas
Design	WHAT: Brainstorming; card games	WHAT: Use best practices and project management to plan and tailor the concept and develop work packages	WHAT: Develop a workflow with milestones, create storyboards, develop template sheets
Develop	WHO: Training Developers and Training Specialists WHAT: Use storyboard and flow charts	WHO: Instructional Systems Design team and developers WHAT: Conduct in-progress reviews with customer, the course instructor and other key personnel to demonstrate results	WHO: Developer from the Technology Branch
Evaluate	WHAT: Typically talk to supervisors to see how the implemented technology is impacting student performance. Also validates after technology is integrated and evaluated.	WHAT: Use alpha and beta testing; obtain feedback as technology is used. Validate after technology is integrated and evaluated; deploy a Quality Assurance survey to receive feedback as soon as possible	WHAT: Evaluation by an instructional designer for functionality, visual appeal, connectivity, and educational soundness
Technologies Developed and Used	Mobile Applications, Games, computer and web-based training tools	Mobile Applications, Games, computer and web-based training tools; VBS2	Mobile Applications, Games, computer and web-based training tools; VBS2
Technology Specification Tools	Spreadsheet and customer requirements	Spreadsheet and customer requirements	Spreadsheet and requestor SME requirements
Training Schools of Focus	Supports 13F Forward Observer Training, Field Artillery Schoolhouses, 13R Radar Maintenance Training, and Counter Fire Operations	Supports Communications Theory Course, Military Intelligence History Course, Non-Commissioned Officers, Brigade for IMT, Counterintelligence, , 35T Repair and Maintenance, SIGINT, Military Intelligence Captain's Career Course	Supports Combine Arms Support Command (CASCOM) Proponent Schools (Quartermaster Center and School, Transportation School, Ordnance Center and Schools, Soldier Support Institute and Army Logistics University)

The Fort Sill DoTD has an organizational structure that includes an Analysis Branch and Educational Technology Branch that is directly involved with training development and learning technology selection. The Analysis Branch typically performs the Analysis phase and some of the Design phase of the ADDIE process. It employs several brainstorming and investigative techniques for both processes, and works with the customer throughout the process. Since the majority of the work supports institutional training, the Analysis Branch initially defines the

problem, examines the critical skill task list, and considers any previous education that the training audience has received. It employs the Analysis process to define the target audience and training requirements, and to develop training objectives. In the Design phase, the Analysis Branch uses several techniques to brainstorm ideas for presentation and transfer of knowledge. In the Development phase, the Analysis Branch works with media specialists to create the technology medium that will be used for training.

The process at Fort Huachuca begins when the training design and development team receives a request for a new learning technology. The team initiates a kickoff meeting with the customer to brainstorm, capture training requirements, and to request Government Furnished Information (GFI), which includes lesson plans and critical task lists. During the Analysis phase, the team determines the true training gaps and needs and then meets again with the customer to demonstrate proof of concept. During the Design phase, the ISD team and developers work together, using best practices and project management to plan and tailor the concept, and develop work packages. During the Development phase, the team conducts in-progress reviews with the customer, the course instructor, educational specialists, training specialists, and other key training personnel to demonstrate the results. Then, alpha testing is conducted in-house, modifications are implemented, and beta testing is conducted with selected users. Before the technology is ready to be implemented, it may require a certificate of networthiness (CON), which may take between three and 18 months to receive. After implementation, the team gets feedback as early as the product is used.

At Fort Lee, the Technology Branch team meets with the customer or requestor subject matter expert (SME) to develop ideas for turning a current product into a technology best suited for training and to discuss the amount of development time needed. The two parties develop a workflow with milestones, create storyboards, and develop template sheets. A developer from the Technology Branch then develops the product, and an instructional designer evaluates it based on functionality, visual appeal, and connectivity as well as educational soundness (i.e., determines whether it is intuitive to use, determines its text/graphic value, and determines whether it is worthy of release).

Potential Constraints on Adopting Principles

One of the main goals of the interviews was to understand which technology specification principles are currently implemented at the training site. Principles that are already implemented at the Army training locations include the following:

- *Technology benefits must be considered specifically in the context of the particular learning environment in which it will be used.* Each of the three Army training centers discussed the importance of considering the environment in which training will occur to make the best specification decisions. For example, one of the interviewees at Fort Sill discussed that the cost of Internet for use by a deployed Soldier may be too expensive and, thus, would not serve well as a learning technology.
- *To fit technology into training, instructors should focus on identifying the cognitive requirements of the learning objective in tandem with the specific affordances of technologies.* A discussion about learning objectives as one of the first and most

important considerations when making specification decisions occurred at all three training centers. More specifically, at Fort Lee, the requestor SME (i.e., the customer) provides the requirements for technology, and the TIO incorporates those requirements into the workflow process. At Fort Huachuca, the designers get to know the learners. If learners are experiencing trouble with particular concepts, then the developers may create animation to illustrate the challenging concept. The designers at Fort Sill also examine the nature of activities and learning objectives, and match the two so that students learn the requisite skills. In addition, the designers examine how the learning technology will support learning, determine whether the learning will consist in standardization training or familiarization training, and work with SMEs (e.g., NCOs) to examine the critical training tasks.

- *Consider trainee experience level when selecting high-fidelity technologies.* At Fort Sill, the learners mentioned the inclusion of learning distractors, or items such as wind, dust, noise, and movement that could be added to a simulation, for instance, to increase the realism of working in the operational environment. Learning distractors would not be included in the simulation for low-experience learners.
- *Consider trainees' backgrounds and expected interest in course material when selecting technology*. Each of the three training locations considers the learners' levels of expertise and backgrounds (i.e., their MOS, familiarity with current technology, etc.). However, it remains unclear whether learners' expected interest is a consideration.
- *The size of the training course may impose limitations on the presentation method and technology*. All locations mentioned course size as a consideration, although perhaps not the most important factor to consider. In particular, Fort Sill mentioned the relationship between the number of students in a course and the number of available computers. A one-to-one relationship between student and computer in a course fails to facilitate collaboration. On the other hand, this ratio forces each student to engage in the activity and participate in the course exercise. Networked computers allow, but do not necessarily enforce, student collaboration
- *Incorporating more technology into an instructional design does not always guarantee better learning outcomes*. The training centers acknowledge that technology specification is based on the training objectives and is intended to support learning. This principle is currently in use, although the command may request a particular technology against the guidance from the developers.

The principles that were identified in the academic literature but were not expressed by the interviewees include:

- The manner in which a technology is presented and the way it is used can have a large impact on which affordances are realized.
- There is a need to properly educate instructors about the technology in order to maximize the learning affordances. Although this education is available and is beginning to be included in some Army instructor training programs, there remain many programs in which it is not adequately addressed. This forces the instructors to educate themselves on their own time, but only if they are so motivated to learn about the technologies.
- Depending on the knowledge or skills to be trained, greater emphasis should be placed on the learning experience that will yield the most effective educational process.

- Because cognitive load increases with the number of different information modalities used, one strategy is to use technology that relies only on the modalities most relevant to the training objective.
- To maximize learning effectiveness, the technology may need to be modified to better suit the trainee characteristics, learning objectives, and environmental constraints.
- To maintain student engagement when training highly technical skills or teaching topics in which students may not take an interest, use interactive technologies.
- Personalized experiences, such as those created by immersive, interactive technology, may lead to increased trainee engagement.

The Technology Factors Survey also generated discussion of additional considerations that are made when selecting technology for training. The completed surveys (with additional considerations) were analyzed to determine which factors are considered to be the most critical for selecting technology. The "1" to "5" ranking associated with each original survey item suggest that the following factors are the most important to consider when making technology selection decisions: *familiarity with technology* (M = 4.18, SD = 1.01), *supportive climate for innovative training techniques at your training facility* (M = 4.71, SD = 0.47), *reliability of the technology* (M = 4.75, SD = 0.62), *cost* (M = 4.25, SD = 0.86), *training or learning objectives* (M = 4.94, SD = 0.25), *availability to the instructor* (M = 4.60, SD = 0.63) and *to the student* (M = 4.73, SD = 0.46), *learning preferences* (M = 4.41, SD = 0.92), and *improves learner engagement* (M = 4.41, SD = 1.08; see Table 2).

The additional factors and considerations that the participants included at the end of the survey are listed in Table 3 on the following page and were leveraged to make sure the considerations that are included in the technology selection process are operationally relevant (note that the highlighted rows indicate which factors were mentioned by participants at all three training locations). An analysis of the data collected at the sites as well as the outcome of the literature review drove the development of the learning technology selection process as described in the next section.

Table 2
Results of the Technology Factors Survey

	Training Center				
Considerations	**Fort Sill**	**Fort Huachuca**	**Fort Lee**	***Mean***	***Standard Deviation***
New technology available	3.86	4.25	2.92	*3.62*	*1.22*
Familiarity with particular technology	4.43	4.75	3.50	*4.18*	*1.01*
Supportive climate for innovative training techniques at your training facility	5.00	4.50	4.50	*4.71*	*0.47*
Fidelity of the technology	4.00	4.25	2.33	*3.47*	*1.18*
Reliability of the technology	5.00	4.75	4.00	*4.75*	*0.62*
Cost	4.17	4.00	4.50	*4.25*	*0.86*
Training or learning objectives being trained	5.00	4.75	5.00	*4.94*	*0.25*
Availability of technology to the instructor	5.00	4.00	4.67	*4.60*	*0.63*
Availability of technology to students	5.00	4.25	4.83	*4.73*	*0.46*
Number of students in training (course size)	3.17	3.00	4.00	*3.44*	*1.09*
Field and resource constraints	4.60	3.50	3.67	*3.93*	*0.88*
Trainee rank or level	3.71	4.25	3.83	*3.88*	*1.27*
Learning preferences	4.67	4.25	4.25	*4.41*	*0.92*
Improves engagement	3.83	4.75	4.75	*4.41*	*1.08*

Table 3
Additional Factors and Considerations By Training Center

Factor	Fort Sill	Fort Huachuca	Fort Lee
New technology available	x		x
Fidelity of the technology/ realistic	x		x
Reliability of the technology	***x***	***x***	***x***
Cost of the technology (or cost savings)	***x***	***x***	***x***
Availability of the technology to the instructor	***x***	***x***	***x***
Availability of the technology to the students	***x***	***x***	***x***
Field and resource constraints	***x***	***x***	***x***
Relevancy (to operational environment, job)		x	
Usable (user experience, face validity)			
Interactive			
Engaging	***x***	***x***	***x***
Visually appealing			x
Educational soundness			x
Functional			x
Connectivity			
Easy to use			x
Stability	x		
Feedback mechanisms			
Management/ upkeep			
Ability to integrate pre-existing course structure			
Hardware/ software requirements			
Technical support resources (i.e., existing infrastructure)			
Incremental value of the technology over traditional techniques (i.e., avoiding the novelty factor, cost of traditional learning methods compared to tech, return on investment)			
Best to distribute content (i.e., delivery method); presentation/distribution	x		x
Reason behind use (reason for use, informed decisions with instructional design)			x
Time to design/develop/implement technology	x		
Learning distractors (as in realism, customizable fidelity)	x		
Who will conduct the training (i.e., can you develop it to be standalone?)	x		
Security of the technology/ security concerns (sharability of devices)	x		
Ergonomics (e.g., smart phone has a small screen, which dictates content and use)	x		
Is it intended to supplement versus replace current training	x		
Will it improve current technology			x
Does it support/enable retention - ability to help students keep knowledge (does it enable learning, does the student learn from the technology; how will it help your audience learn)	***x***	***x***	***x***
Chaining technology together - dL intro, classroom sim, app review mechanism			x
Time issues as it relates to team workflow/job time			x
Where are we (as designers) going with it?			x
Network considerations			x
Technology should be relevant - training should be scenario-based and timely (up-to-date) and realistic to eliminate distractors		x	

Table 3 (*continued*)

Factor	Fort Sill	Fort Huachuca	Fort Lee
Technology should be designed to scaffold the learner		x	
Tech should be easy to use or else the training becomes about learning the technology rather than completing the terminal learning objective		x	
Amount of time given to deliver training		x	
The importance of utilizing technology is highly relative to the instructional goal. Instructional design and use of technology does have to consider the environment, the infrastructure, the capabilities, the constraints, the tasks and learning required for the mastery of competencies, but ultimately if the technology does not support the instructional goal then it becomes unimportant. It does not further support the required learning objectives and provide the learner with optimal experiences in learning the intended outcomes, then it becomes extraneous		x	
Sustainability			x
What is being trained (i.e., the training or learning objectives for a particular training event)	***x***	***x***	***x***
Type of training (i.e., standardization, familiarization)	x		
Creation of support packages for the learning technology	x		
Level of Bloom's you are going to use	x		
Task learning difficulty	x		
Familiarity with particular technology	***x***	***x***	***x***
Number of students in training/course size	***x***	***x***	***x***
Rank or trainee level	***x***	***x***	***x***
Students' learning styles or preferences	***x***	***x***	***x***
Student engagement	***x***	***x***	***x***
Motivation to learn and to use the technology			
Who is your target audience and how will it help them (will the student learn from the technology?)	x		x
Instructor-to-student ratio	x		
If developing technology, are the developers (IT folks) that do the actual development familiar with the technology? How closely does it resemble other technology with which they have developed?			x
Opportunities to use technology in a course		x	
Motivation to instruct and use the technology			x
Supportive (organizational) climate for innovative training techniques at your training facility	***x***	***x***	***x***
Decision makers deciding to fund it			
Learning distractors (within the environment)	x		
Safety	x		
Institutional, operational, or self-development	x		
Training environment	x		
Virtual versus co-located learning	x	x	

Note. Highlighted rows indicate those factors mentioned across all three locations.

Process Development

Based on the interview findings, it appears that the general principles obtained from the literature are in use across all three training centers (i.e., considering the learning requirements, training audience, technology attributes, and learning environment). However, to account for additional considerations that were discussed, such as those listed in the two tables above, those four general principles were revised to ensure all critical factors were captured in the learning

technology specification process. As described in the section below, one critical factor described during the interviews focused on resources and constraints (e.g., technology cost; need for power supply). Therefore, it seemed necessary to revise the four general principles from the literature to include a separate resources and constraints category. In addition, the learning environment principles were revised to fit within the resource and constraints factors since many of them (e.g., class size) may place constraints on the learning technology that could be implemented. Third, training audience seemed to be an overarching principle that influences the other groups of principles and should be considered prior to selecting technology as well as throughout the selection process. For instance, the learners' past experiences will impact the initial learning objectives (i.e., experiences impact learning requirements). As a result, the four general principles were reduced to three principles of technology specification: consider the learning requirements, the technology attributes or capabilities, and the resources and constraints. Those three general principles guided the development of the three matrices that form the learning technology specification process: the Learning Requirements Matrix, the Technology Capabilities Matrix, and the Resources and Constraints Matrix. The first matrix facilitates thoughts about the training objectives and how the training will achieve them; the second matrix describes technological capabilities that support learning and the activities required to achieve training goals; and the third matrix focuses on the resource considerations that would shape technological capabilities being considered for training.

Each matrix consists of a set of questions that are intended to help training designers and developers understand and think critically about the types of considerations they need to make when selecting learning technology. Those questions were developed from the analysis of the data collected and the literature that was reviewed. There are three response considerations for each question intended to point the user to the critical technology requirements that will support learning, and which should be used to drive technology specification.

Final Process

The Learning Technology Specification Process presents the important factors that a training designer or developer should consider when selecting technology for training; conversely, the process can also be used to validate that a technology that has already been selected fits with the current requirements. The Learning Technology Specification Process may be implemented in conjunction with new course development or to replace training in a current program of instruction. The process fits within the Design phase of the Army's instructional system design process, ADDIE (Figure 1). The user must have completed the steps in the Analysis phase in order to effectively use the Learning Technology Specification Process. The user must know the training objectives or learning outcomes, training audience, training location, and other information about the training that result from the Analysis phase of ADDIE.

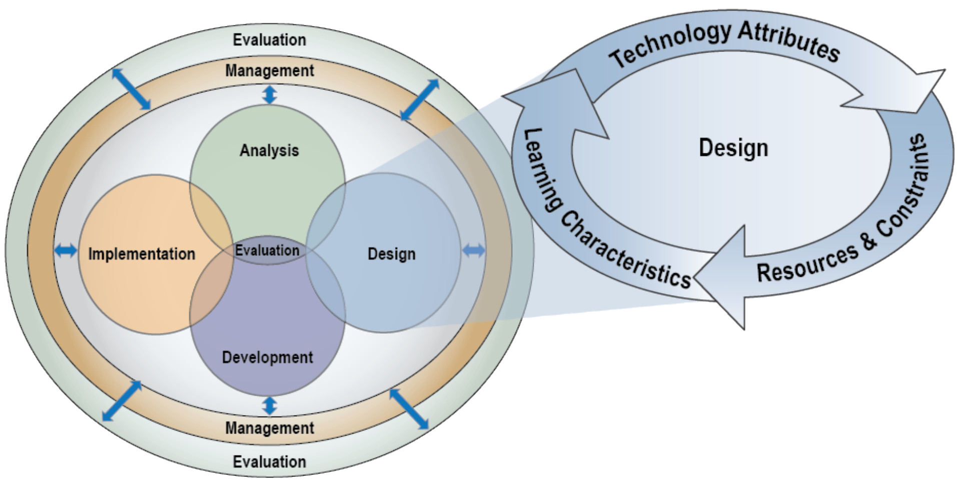

Figure 1. **Technology specification process embedded in ADDIE**.

How It Works

The Learning Technology Specification Process comprises three steps, each of which is represented by a matrix: (1) the Learning Requirements Matrix, (2) the Technology Capabilities Matrix, and (3) the Resources and Constraints Matrix. The matrices will ideally be discussed in a group setting to promote collaborative thinking and foster discussion about the critical technology requirements. Although it is recommended that training designers and developers use the matrices in the order in which they are presented, they may tailor the process to best meet their needs. A template for implementing the process is provided at Appendix E; a detailed description of the template follows below.

The users are first asked to think about the training objectives or desired learning outcomes that the training should achieve as well as the training audience (i.e., the learners' ranks, levels of experience, other relevant background information) and record this information in the Learning Technology Specification Guidelines template.

While thinking about training objectives and the training audience, users are then guided to the Learning Requirements Matrix (Figure 2) and are asked to read through each of the questions in this matrix and circle the answer that best describes the training goals and learner characteristics.

Learning Requirements	**Once you have determined a critical learning requirement, think about how the requirement will be filled. Is technology needed, or is there another mechanism to help you meet the requirement?**		
What level is the training intended to promote?	The training involves higher order skills such as critical thinking, problem solving, and leadership	The training is oriented mostly toward procedures.	The training is oriented mostly toward declarative knowledge.
Will there be a need to exchange information remotely?	It is necessary for training content to be published and for learners to remotely access and respond to the content.	It is necessary for the training content to be published and for learners to have remote access to content.	No information needs to be exchanged remotely.
Is it necessary to provide formal feedback (e.g., tests and formal assessments)?	Informal feedback is critical to meeting the objectives of this training.	The learner must be able to request and receive informal feedback.	Informal feedback is not necessary given current objectives and training audience.
Is it necessary to provide formal feedback (e.g., tests and formal assessments)?	Formal feedback is critical to meeting the objectives of this training.	The learner must be able to request and receive formal feedback.	Formal feedback is not necessary given current objectives and training audience.
Will training that adapts to learner needs and knowledge states help to meet learning and training objectives?	Adaptive training is critical to meeting the objectives of this training.	Adaptive training may be necessary for some, but not all, training objectives.	Adaptive training is not necessary given current objectives and training audience.
Will immersive experiences help to meet learning and training objectives?	Embedding immersive experiences is critical to meeting the objectives of this training.	Immersive experiences may be necessary for some training objectives.	Immersive experiences are not necessary given current objectives and training audience.
Will opportunities for hands-on learning and exploration help to meet learning and training objectives?	Hands-on learning opportunities are critical to meeting the objectives of this training.	Hands-on learning may be necessary for some objectives but is not necessary.	Hands-on learning opportunities are not necessary given current objectives and training audience.
Will collaboration help to meet learning and training objectives?	Collaboration is critical to meeting the objectives of this training.	Collaboration may help promote some training objectives but is not necessary.	There is no need for collaboration among learners given current objectives and training audience.

Figure 2. **Learning Requirements Matrix**

There are three possible response areas to each question. For example, the first question in the Learning Requirements Matrix asks, *What level is the training intended to promote?* The three response options include:

(1) *The training involves higher order skills such as critical thinking, problem solving, and leadership;*
(2) *The training is oriented mostly toward procedures.*
(3) *The training is oriented mostly toward declarative knowledge.*

After answering each question, users complete the Summary table by listing the Critical Learning Requirements (or the responses that have been circled in one of the first two columns of the Learning Requirements Matrix). The users are also asked to describe the ways in which learning technology may support the learning requirements just listed in the Summary Table (Table 4). For example, if "procedural training" is the best response to the question *What level is the training intended to promote?*, then consideration of technology might turn to some sort of part-task trainer.

Table 4
Learning Requirements Summary Table example entries.

Critical Learning Requirements	Technology Requirements
E.g., Must support procedural training.	E.g., Procedure has only one branch/decision point, must be performed within time limit and with no omissions.

Next, the users are guided to the Technology Capabilities Matrix (Figure 3) to help them think about the ways in which technology will support the critical learning requirements that have been identified by reviewing the Learning Requirements Matrix and circle the answer to each question that best describes the capabilities required of the learning technology.

Technology Capabilities	If technology is needed to help you meet the necessary learning requirements, think about the capabilities that the technology must possess.		
Is there an anticipated need to edit or upgrade the technology?	The technology must be edited or upgraded often.	The technology will need to be edited or upgraded periodically.	The technology does not need to be edited or upgraded.
Will the technology need to be repurposed to support other content or instruction?	The technology must have the flexibility to be re-used or re-purposed. (Complete guidelines for that training/instruction if appropriate)	The technology may be available to support other content or instruction.	The technology can serve a single training/learning purpose.
Does the technology need to replace the instructor?	The technology must replace the instructor.	The technology must augment part of the instruction or support the instruction.	The technology does not need to replace the instructor.
Does the technology need to deliver instructional content?	The technology must serve as an instructional content delivery tool only.	The technology will be used to deliver instructional content and for other purposes.	The technology does not need to deliver instructional content; it will only be used for other purposes (e.g., assessing performance).
Does the technology need to support immersive training environments?	The technology must support immersive training.	The technology must augment an immersive environment.	The technology does not need to support immersive environments.
Does the technology need to replicate a system (e.g., weapons system) or equipment?	It must match the system or equipment exactly.	The technology should replicate some but not all functions of the system or equipment but not match exactly.	The technology does not need to replicate a system or equipment.
Does the technology need to be high fidelity?	The technology must have high physical fidelity.	The technology must have high training/psychological fidelity.	Fidelity is not a concern.

Figure 3. **Technology Capabilities Matrix**.

For example, one of the questions in the Technology Capabilities Matrix asks *Does the technology need to replace the instructor?* The possible response options include:

1. *Yes, the technology must replace the instructor;*
2. *The technology must augment part of the instruction or support the instruction;*
3. *No, the technology does not need to replace the instructor.*

Any items in the first two columns of the Technology Capabilities Matrix should then be listed in the Critical Technology Capabilities column of the Technology Capabilities Summary Table (Table 5).

Table 5
Learning Requirements Summary Table example entry

Critical Technology Capabilities
E.g., The to-be-learned material will not be addressed by the instructor; the technology must provide its own instructor functionality.

While thinking about the critical technology capabilities identified in the Technology Capabilities Matrix, the users are then asked to read through the questions in the Resources and Constraints Matrix (Figure 4) and circle the answer that best describes the available resources and limiting factors that affect the decisions to select and implement learning technologies in training.

Resources and Constraints	What are the resources and constraints that enable or inhibit the use of technology? Thinking about the resources and constraints will let you understand if you are able to meet the critical requirements you determined in the other matrices.		
Where is the training taking place?	In the institutional domain.	In the operational domain.	In the self-development domain.
What level of resources (e.g., bandwidth) or infrastructure required to implement a technology can be supported?	A high level of resources can be supported.	A medium level of resources can be supported.	A low level of resources can be supported.
Will there be time and resources available to train instructors on how to use the technology?	There will be resources available to provide training to the instructors on how to both operate and employ the technology.	There will only be resources available to train instructors on how to operate the technology	There will be no resources available to provide training to the instructors on how to use the technology.
What level of on-site support for instructors is available?	A high level of on-site support is available.	Some support is available on site.	Support is available only off-site.
How available must the technology be to the learner?	The technology needs to be always available to the learner.	The technology needs to be sometimes available to the learner, but the time at which it is available is flexible.	The technology can be available only during specified times.
Is the technology capable of self-power?	The technology is capable of providing its own power supply.	The technology is capable of providing its own power supply for a limited amount of time (e.g., after 8 hours of use) and must be re-charged.	The technology is not capable of self-power and requires an external power source.
Does the technology need to be portable?	The technology needs to be used in a variety of environments or areas.	The technology needs to support both a traditional classroom as well as other environments.	The technology has no portability requirements.

***Figure 4*. Resources and constraints**

Where will technical development be conducted?	Technical development can be conducted in-house.	Technical development must be outsourced, but within another military organization.	Technical development will be performed by a second or third-party developer (i.e., contractor).
What is the level of management/organizational support to use the technology?	There is a high level of management/ organizational support.	There is a moderate level of management/ organizational support.	There is a low level of management/ organizational support.
What is the class size?	The class size is large (greater than 30 learners).	The class size is medium (20 to 30 learners).	The class size is small (less than 20 learners).
What is the development timeline (from decision to implementation) for the technology to be implemented in training?	The technology is required within 6 months.	The technology is required within 18 months.	The technology is required in 18-24 months (or longer).
What is the available budget?	There is a large budget available for technology.	There are some budgetary constraints, but not too much to be concerned with.	There is a small budget available for technology.

Figure 4. **Resources and Constraints (continued)**

For example, the question, *Where is the training taking place*, allows three response areas:

(1) In the **institutional** domain;

(2) In the **operational** domain;

(3) In the **self-development** domain.

By examining the items in the Resources and Constraints Matrix, the users understand the possible constraints they must consider when making decisions to use learning technology and determine within which constraints they must work. By circling the various response options that best describes the training goals, the training designer and developer is left with a set of learning technology requirements that enables them to identify or develop a particular technology to use in training. Appendix E provides an example of a completed Learning Technology Specification Process.

To support the use of the technology specification process, a course outline in draft TSP format was developed to assist training designers and developers on how to use the process (Appendix F). The outline provides one terminal learning objective (TLO), which is to

Implement the Learning Technology Specification Process and five enabling learning objectives (ELO), which are to

(1) *Explain the Learning Technology Specification Process*,

(2) *Complete the Learning Requirements Matrix*,

(3) *Complete the Technology Capabilities Matrix*,

(4) *Complete the Resources and Constraints Matrix*, and

(5) *Analyze your results from the three matrices*.

For each ELO, the outline recommends discussion points; for example, given the second ELO, the instructor should provide a definition of the matrix, discuss the goals of the matrix, describe how the user will navigate through the matrix, and discuss the questions in the matrix and how they enable the user to identify various requirements. The outline provides an example practical exercise that could be used in the course as well as other guidance for instructing training designers and developers on how to use this process.

Discussion and Conclusions

The ALM (Department of the Army, 2011) emphasizes the need to adapt current learning models to include technology-related considerations. Potential benefits include lower training costs, providing students with engaging and immersing experiences, and mobile training tools that enable anytime/anywhere learning. This report describes the development of a process to guide the users through the various considerations and factors that are critical to making specification decisions. Drawing on the technological application of learning science without ignoring the craft of current best practices (cf. Clark & Estes, 1998), it considers the learning objectives via an examination of the relevant learning characteristics in order to determine how the technology will support learning. The process examines the physical attributes of the technology types that enable learning and support the objectives. Finally, the process considers the resources that are available as well as the constraints that training designers, developers, and instructors must work within. In sum, this process will efficiently guide and support training designers and developers through technology specification.

The process developed in this research was designed to be "technology agnostic," meaning that it does not recommend one specific technology that will be most effective. Instead, the outputs of the process are critical requirements that training developers and designers must use to select the most effective learning technology. The advantage to not prescribing a technology is that the recommendations generated from this process should stand the test of time. Just as the Army is moving away from traditional learning methods to more technology-focused training, training foci are likely to change again in the future. The more generic nature of the process should enable its use even as new technologies are introduced. Moreover, the learning

principles that serve as the backbone of the process should not change. Training developers and designers and other stakeholders should continue to focus on the "science of learning" when implementing any new technology or training methodology. The process put forth here attempts to highlight the learning principles that need to be considered in any situation.

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Appendix A

Matrices Depicting Relationships Between Technologies and Considerations

Reference	Technology	Benefits for Training Objectives	Training Considerations (e.g., constraints, cost efficiency)
Li, Santhanam, & Carswell (2009)	Animation	Associations and relationships between data	
		Trends in data	
		Explanation of processes	
		Flow of objects	
		Information flows	
		Locational information and spatial relationships	
		Geographic and 3D information	
		Combination of temporal and spatial information	
		Working of complex systems	
		Changes in states and physical structures	
Dobbs (2006)	Wiki		Easy to develop private and/or public knowledge bases
			Inaccurate information is possible
			Cost effective
	Blog		Increases informal learning
			Accessible to large audiences, encourages collaboration and communication, available on mobile devices
			Inaccurate information is possible
	Video log		Distributes video content
			Easy audio and visual communication through Internet
			Slow and disjointed communication is possible
			Personalized training packages
	Podcast		Delivery of self-published broadcasts
			Not very widespread as a media source
TR 350-70 Army Learning Policies and Systems	Mobile devices	Critical thinking and problem-solving skills needed for operational adaptability	

	Virtual and constructive simulations		Reduces instructor-led slide presentation lectures and allows for blended learning approach
	Gaming techniques and technology		Reduces instructor-led slide presentation lectures and allows for blended learning approach
	Gaming technology		Provides realism and operational relevance to game-based learning
TR 350-70-12 Distributed Learning	Animation, video	Demonstrates an action	
	Animation	Demonstrates processes that are difficult to visualize	
		Demonstrates procedures requiring motion and stimulate critical thinking and discussion	
	Video	Stimulates critical thinking and discussion	
DoD Handbook for Instructional Systems Development/Systems Approach to Training and Education (2001)	Printed materials, computer video presentation, audio recording, multimedia presentation of information, video, part-task trainers, simulators		Format
			Feasibility (determine whether the selected media is practical, affordable, supportable)
			Resource constraints (funding, facility availability, equipment availability)
TP 350-70-2 Multimedia Courseware Development	Interactive courseware (e.g., text, programmed instruction, audiotapes, videotapes, slides, films, television, computers)		Personalized (learner-centric)
			Addresses one or more of the human senses
	Simulation	Objectives requiring hands-on exercises	
			Safe practice/training (substitute for experiences when danger and costs are high)
			Train an individual or distributed over LAN/WAN
			Conduct practical, hands-on exercises
			Time savings
			Scenario authoring
	Tutorial	Procedures or guidelines	
			Text feedback
			New material
			Tailored instruction and feedback
			Tailored responses to questions
			Record performance in real-time
			Minimize instruction needed

			Identify remedial instructional requirements
	Game	Response strategies	
		Decision making skills	
		Implementing actions	
		Problem solving skills	
			Practice
			Feedback
			Competition
			Enhanced training techniques
			Evaluate problem solving skills
Spain, Priest, & Murphy (2012)	Adaptive training systems, Computer-based training		Resource intensive
			Requires expertise in ISD and HCI
O'Bannon, Lubke, Beard, & Britt (2011)	Podcast		Easy distribution (no geographical barriers)
			Ideal length = 5 to 20 minutes
			Pair with visuals and music clips at the start and end
Kong (2011)	Cognitive computer tool (interactive program)	Abstract concepts	
		Tasks	
			Visual representation
			Graphical manipulation
			Immediate feedback
			Increases engagement
Thomas et al. (2012)	Visual aid (videos)	Broad range of topics (literacy, math, social studies)	
			Differentially effective for diverse learners
Watkins & Hufnagel (2007)	Camtasia (videotaped PPT that shows evolution of answers)	High technical content and hands-on components	
			Time consuming to produce
			Attach graded assessments to motivate students
Talbot (2011)	Computer games	High-order thinking skills	
		Trying new tasks	Low-risk solution (no consequences)
Salas, Wilson, Priest, & Guthrie (2006)	High-fidelity simulators and virtual reality		Must conduct diagnostic assessments and provide feedback to determine training outcomes
			Combine with other tools

	Simulations/games		High fidelity is not always the better option (e.g., flight performance scores of cadets using low-fidelity computer game still improves performance on complex skills). Some evidence suggests low-fidelity may result in more skill transfer after training, but this depends on the task being trained
Dror, Schmidt, & O'Connor (2011)	Podcasts		Tailor content for podcast presentation/instruction
			Lose the face-to-face experience
	High-fidelity technology		Highly realistic or high-fidelity may be cognitively taxing, so consider whether realism is necessary for a particular learning objective
	Various visual media	Recognition of details	
			Lessens the cognitive load, enhances learning when non-relevant components are minimized
	Videos		Make it interactive
			Incorporate feedback to enhance learning
	Gaming	Coordinated team training	
		Time pressure situations, distractions/non-ideal situations	
	Simulations		Allows students to explore and see consequences of actions without the constraints of needing to be correct
			Allows for restarting
Krauskopf, Zahn, & Hesse (2012)	Videos		Must know what videos afford in terms of learning to maximize training effectiveness using this media
Antes & Schuelke (2011)	Simulation	Leadership skills (scanning, problem definition, idea generation, planning and implementation	
			Allows training real-world situations at a reduced cost (time and money) than training in the real-world environment
			Unlimited number of practices/specific cases
			Design simulation around case-based knowledge (cases act as basis for creative ideas and provide ideas about implementation)

Bedwell & Salas (2010)	CBT (computer based technology)	Declarative or procedural knowledge (demonstrated as graphics or animation)	
			Inexpensive
			As equally impactful as face-to-face training
			Group related material onto single computer screen if possible to reduce cognitive load
Dalgarno & Lee (2010)	3-D virtual learning environments	Spatial knowledge representation	
		Experiential learning	
		Contextual learning	
			Allows for immersion, fidelity (display and other technical specifications), active learner participation (learner interfacing with the system in terms of communication, control, navigation)
			Better than interactive media for supporting immersion and interaction between learner and system
			Consider whether the learning tasks require this level of fidelity or immersion to achieve the training objective (more high-tech solutions are not always better of necessary to accomplish training goals)
			Affordances include development of enhanced spatial representation of a particular domain, providing experiential learning activities when they are not feasible in a real-world environment, intrinsic motivation (i.e., learners are more engaged and will utilize training more frequently than other medium), improved transfer of knowledge and skills to real-world situations through contextualized learning (i.e., less of a difference between simulation and reality than other mediums), and effectively facilitates richer collaborative learning experiences
			Encourages engagement
			Encourages collaboration
Moreno & Mayer (2007)	APA (animated pedagogical agent)		Highly visual (not always relevant to the learning objective, and in these cases, does not increase learning)
			Useful for guiding learner attention to relevant parts of a presentation or mimicking actions related to a particular learning objective

	VRE (virtual reality environment)		Highly immersive (but may not always be relevant to the learning objective; e.g., did not help learning botany)
Cannon-Bowers & Bowers (2008)	SLE (simulated learning environment)		Use to substitute practicing in real environments that may be too dangerous or impractical for training
			Allows for multiple practices of an otherwise infrequent event (e.g., emergency procedures)
			Contains embedded instructional features/feedback to augment the learning experience
			Less costly than training on actual equipment or in real-world operational environments
			Not universally effective; need to consider the fit between medium and learning objective
			Must consider learner characteristics (i.e., learner must be comfortable with this technology and consider the training goal)
			Trainee's spatial ability may determine SLE's effectiveness on training
	Video games	Visual attention skills	
	Scenario/case design SLEs		Useful for triggering events/situations that prompt a specific kind of result/reaction that the learner can practice
			Time consuming to create SLEs
			Must consider guidance for learner training goals/roles in SLE to be most effective
	Avatars in SLEs		Facilitates establishment of user identity and makes for more personalized experience-- this fosters learner engagement which promotes learning
			Personalizes the experience, which fosters learner engagement
Wilson et al. (2008)	Games	Skill-based learning	
			Increases interest in training
			Due to its psychological fidelity, learners use the same cognitive processes as they would performing the task in reality
			There is a positive relationship between the level of challenge in a game, declarative knowledge, and retention; best if the level of challenge is moderate
			Increase adaptation features in the game to improve the learner's cognitive strategies

			As the fidelity of the game increases, psychomotor skill learning increases, but only to a particular extent (then levels off so higher fidelity is no longer better)
			Physical and psychological representation in a game increases learner motivation
Mylott (2008)	Web-based content		Content must be web-friendly (i.e., reduce text, include bullets and attention-grabbing phrases, use pictures and graphics to tell a story)
			Develop short chunks of learning mixed with interaction
			Do not use more than 2 or 3 different fonts within a course (Sans Serif fonts like Arial are easiest to read)
			Consider bandwidth limitations (i.e., keep image and video file sizes small)
			Longer and more complex courses are not as effective when completely virtual - use mixed methods
			Consider virtual environments for learners (access to headphones, technology, and the Internet)
			Conducive to cheating (online tests and assignments)
			Allow users to have control over the flow of information, but the logical flow of information should be obvious
	Video		Time consuming
			Costly to develop
			Difficult to update content
			Consumes much of the bandwidth
	Games		Highly motivating and makes learning fun
Mikropolous (2009)	Educational virtual environments		Immersive features enhance learning by allowing multiple perspectives, situating learning, and transfer of training
			User characteristics may play a role in learning outcomes, but have not been explicitly investigated
	Virtual reality	allows for first order experiences stemming from affordances of 1st person POV, natural semantics, size transduction, reification, autonomy, and presence	Affords first-person point of view, natural semantics (promotes knowledge construction by avoiding use of symbols), size transduction, reification, autonomy (useful for experiencing situations that are difficult to achieve in reality and creating mental models for knowledge construction), and presence
	Educational virtual environments		Supports collaborative knowledge construction through social negotiation
			Fosters reflective practices

			Affordances include spatial knowledge representation, experiential learning, engagement, contextual learning, and collaborative learning
Pridmore (2010)	Multimedia	Better than lecture is for behavioral learning outcomes (such as learning interest and motivation)	
			When students are novice to the material, it is best to pair multimedia with lecture first to establish a knowledge base from the instructor; then more independent, student-driven learning can build on top through multimedia
			Lecture is better than multimedia for cognitive learning outcomes that focuses on a basic understanding of course content
			Multimedia is better than lecture for behavioral learning outcomes (e.g., interest and motivation)
			Multimedia is better than lecture for cognitive learning outcomes that focus on application rather than understanding of basic course concepts
Feinstein & Cannon (2002)	Simulators		Cost effective for novice trainees to use low-fidelity devices during first stages of learning
			Does not have to be a completely realistic representation of the real world for training effectiveness; may benefit the learning objective to deviate from realism
Gill (2007)	PowerPoints (creation tips)		Choose a format that does not require much set up by the student (if delivering via the Web, Windows media viewer and flash are desirable)
			Do not include unnecessary screen effects (e.g., slide transition effects), which can interfere with playback and file size
			If incorporating a voiceover with a demonstration or animation, do not add a talking head graphic, which is unnecessary and increases the file size
Zdravkova et al. (2012)	Social networking		Negative student reaction to forced usage in class
	Online testing		Problematic due to plagiarism/sharing of tests (students who complete it first share the answers with other students)
	Online forum (discussion board)		To increase quality of posts, assign end grade to each participant based on post quality

	Online chats/blogs		Not well received by the students-- they preferred more traditional forum posting for questions and discussion
	Discussion boards		Be mindful of using discussion boards for potential sensitive subject material-- students posting personal beliefs different from others may get attacked and so instructor must monitor board; allowing students to be able to remove posts they post with 1/2 hour is desirable
	Web 2.0 technologies (wiki, discussion board, etc.)		Crucial to have reliable server, internet access for all students, and responsive instructor
Shih et al. (2006)	Web-based training tools		While student experience with technology affects the way they go through the course (experienced users distribute work into more, shorter sessions while inexperienced do fewer, longer sessions), the overall training efficacy isn't much different
Orvis et al. (2008)	Video games	Completion of instructional games lead to improvements in motivation and task performance	
			Difficulty of game should be calibrated to trainee skill level-- too much or too little difficulty decreases learning impact through lowered motivation and time spent on task. Consider design of how trainees progress to different levels. For experienced learners, an automatic (forced) level progression can be appropriate, but not for inexperience learners (the game got too hard too quickly for inexperienced learners). Ideal if game allows instructor to set/modify game difficulty and progression characteristics depending on the given trainee.
Yellowlees & Marks (2006)	Simulations	Practice situations that can be practiced in reality cost-effectively; improve individual and team skills through a collaborative environment	

Huifen & Dwyer (2010)	Animation	Provides learners with external illustrations that aid visualization of knowledge involving changes in direction, speed, and path of travel	
			Student spatial ability levels relate to effectiveness of animation-- high ability use them better, and use of animation is related to performance
			Giving learners control over pace of animation improves performance
			More effective when segmented into smaller parts and key information is cued or signaled in the animation
			Superior to simple static visual aids for these types of learning objectives
			Pairing animation with questions and feedback opportunities did not improve performance when compared to questions only condition.
Doymus et al. (2010)	Animation	Supports representation encoding to augment learning	
			Most effective when paired with verbal support (class discussion) by the dual coding theory of learning from animation. This allows for both representational (animation-based) and referential (verbal-based) encoding. Can also use text or narration with animation in lieu of class discussion.
Mishra (2002)	Web pages, search engine, digital drop boxes	Useful for seeking and collecting information	
	Software to analyze data, concept maps	Useful for organizing information into a coherent framework	
	HTML editors, web page creation tools, word processors	Useful for generating/constructing new knowledge	
	Simulation/animation on the web	Useful for manipulating external information and variables	
Erlandson, Nelson, & Savenye (2010)	Multi-user virtual environments (MUVEs)	Supports collaborative scientific inquiry process	Cognitive overload can be an issue. To lower load, use voice-chat communication technology instead of text-based chat technology-- this improves learning outcomes.

Fiorella et al. (2012)	simulations		Providing feedback in real-time may disrupt the learning process and be distracting. Better to use delayed feedback. If delayed, best to present feedback across multiple modalities (visual, auditory)
			If immediate feedback is used, it's best to present it in a complementary modality to decrease cognitive load: if a visual simulation, give feedback aurally.

Source	Reason for using technology	Examples
Angeli et al. (2009)	Instructing topics that benefit from non-traditional methods, such as topics that are classically difficult to understand or topics with which instructors have had difficulty	Abstract concepts that need to be visualized
		Phenomena from physical/social sciences which consist of certain events and need to be animated (e.g., water cycle)
		Complex systems (e.g., ecosystems) in which certain factors function systematically and need to be simulated or modeled
		Topics requiring multimodal representations (i.e., textual, iconic, and auditory) such as phonics and language learning
	Transforming content into forms that are more comprehensible to learners and are difficult for traditional means to support	Interactive representation
		Dynamic transformation of data
		Multiple simultaneous representations of data
		Multimodal representations of data
	Wanting to use instructing strategies which are difficult or impossible to implement by traditional means	Exploration and discovery in virtual worlds
		Virtual visits
		Testing of hypotheses and/or application of ideas into contexts not possible to be experienced in real life
		Complex decision making
		Creation of cognitive conflict
		Long distance communication and collaboration with experts
		Long distance communication and collaboration with peers
		Personalized learning
		Adaptive learning

Appendix B

Interview Questions for Training Designers and Instructors

The questions listed below are intended to be reflective of a semi-structured interview approach; therefore, we may not ask all of these questions and, alternatively, we may ask additional ones.

Questions for Training Developers

1. *What kind of training do you specifically develop?*
2. *In the training you develop, are there any major training events or exercises? If so, are there specific technologies you use to support these events and exercises?*
3. *How frequently does training occur, and what drives this frequency?*
4. *Have you been a training developer and instructor?*
5. *What do you find helpful about using learning technologies?*
6. *To what extent does technology play a role in your training design plans? What determines this role?*
7. *Which technologies do you use and why? If you did not make the decision to use the technology, who is responsible for making this decision?*
8. *Do you collaborate with other training developers to make these decisions?*
9. *What are the advantages and disadvantages of the technologies you use?*
10. *What are the different methods (e.g., seminar, discussion), techniques (e.g., instructor led, computer-based, presentation, hands-on), and environments (e.g., classroom, field exercise) that you incorporate when you develop training, and what drives the decision to use that method?*
11. *How do you learn about the available technologies to use (is there a central database/resource center)?*
12. *Were you taught a formal process to incorporate technology or is this based on your experiences or a mentor's experiences?*
13. *Where would you insert a process for technology validation within the ADDIE process, and why?*
14. *How do you consider training and learning objectives in your decision to use a particular technology?*
15. *What factors drive the decision to use a particular technology?*

Questions for Instructors

1. *Which courses do you teach?*
2. *What type of training did you go through to become an instructor? What other types of training are available in the Army?*
3. *Have you been a training developer and instructor?*
4. *Do you use any type of learning technology in your course of instruction?*
5. *What do you find helpful about using learning technologies?*
6. *How do you decide which technology to implement in the classroom? Is there a central database/resource center from which you can select particular technologies or is the selection predetermined?*
7. *What type of instruction did you receive on how to operate, set up, and use particular technology? Does this instruction include which learning or training objectives particular technologies would be good for?*

8. *Do you work with training developers to design appropriate training? If so, to what extent do you work with them?*
9. *Is there ever a case in which you modify the instructional plans that are developed for the course? If so, could you provide examples?*
10. *What percentage of the instructional event is using technology? What does the distribution of technology use look like (e.g., is technology used for only one part of the course versus throughout the course?)?*
11. *What do you see as the advantages and disadvantages of the technologies you use?*
12. *What type of learning (e.g., classroom, discussion, hands-on) do students seem to enjoy the most? The least?*
13. *If you had a blank canvas, how would you design your program of instruction or courseware? What technology do you think would support this instruction?*

Appendix C

Technology Factors Survey

Technology Factors Survey
Survey Instructions

The goal of this survey is to identify which factors are most important in the decision to use (or not use) learning technologies in training. *A learning technology is any hardware and/or software (excluding PowerPoint and pen and paper) used to support the learning process for students.*

Please rate the extent to which each factor drives the decision to use one technology versus another on a scale ranging from 1 (not at all important) to 5 (highly important). There is space at the bottom to add other factors you consider when making the decision to use (or not use) technology. Once you have finished the survey, we will discuss your answers.

Factor	Not at all Important	Somewhat Important	Neither Important nor Unimportant	Important	Very Important
New technology available	1	2	3	4	5
Familiarity with particular technology	1	2	3	4	5
Supportive climate for innovative training techniques at your training facility	1	2	3	4	5
Fidelity of the technology (e.g., how important it is to have 3D when 2D might work)	1	2	3	4	5
Reliability of the technology	1	2	3	4	5
Cost of particular technology	1	2	3	4	5
What is being trained (i.e., the training or learning objectives for a particular training event)	1	2	3	4	5
Availability of technology to the instructor (e.g., opportunities to use the technology outside of the time spent on training, accessibility for course integration)	1	2	3	4	5
Availability of technology to the students (e.g., number of training devices, internet	1	2	3	4	5

availability to students outside of class)					
Number of students in training/course size (may affect feasibility of individualized versus group tactics)	1	2	3	4	5
Field constraints and resources (e.g., constraints and resources outside the classroom environment, such as students getting together at a coffee shop to study)	1	2	3	4	5
Rank or trainee level (i.e., level of experience/expertise with training topic, more novice students versus students advanced in their skills)	1	2	3	4	5
Students' preferred learning styles (e.g., auditory, visual, tactile)	1	2	3	4	5
Improves student engagement	1	2	3	4	5

Please list any additional factors that are important to you when considering technologies to use within a specific training event.

____

____

____

____

____

Appendix D

Interview Protocol

Semi-Structured Interviews with Training Developers

Introduction

1. Make introductions and thank the interviewee for his or her time. During the introductions, gather some basic information about the background of the interviewee (education, position, length of time in position, etc.).
2. Describe the purpose and goals of this interview.

   Our goal for this interview is to understand the way in which learning technologies are currently selected and used for Army training. A learning technology is any hardware and/or software (excluding PowerPoint and pen and paper) used to support the learning process for students. What we learn from you during our session today will contribute to the development of an improved process for selecting and integrating technology into training curricula that is intended to maximize training effectiveness. During the interview, we will ask questions about how you develop training for the Army. We may take notes during the interview to help us remember the factors that affect technology selection. Your name will not be associated with this interview or the responses you provide.
3. Have interviewee read and sign the informed consent form.

   Please read Privacy Act Statement and the informed consent form, and sign the informed consent form. It briefly explains the purpose of this research, provides information about your participation, and provides contact information should you have questions after the interview has terminated. These documents also let you know that everything you say today will be anonymous, so please be honest in your responses.
4. Provide instructions to the interviewee.

   This interview should take approximately one hour. First, we will ask you to fill out a survey asking about the factors that play a role in your decision to use technology for training. Next, we will have you walk us through how you develop training so we can understand your experiences as a training developer. After, we'll ask you a set of questions and discuss your survey responses to ensure we have a correct understanding of those factors that are most important to consider when selecting and integrating technologies into training. Lastly, we'll recap the interview, ask any follow-up questions we may have, and answer any questions you may have for us.

Present Survey

Please take a few minutes to complete the survey. The goal of this survey is to identify which factors are most important in the decision to use (or not use) learning technologies in training. Be sure to read the instructions and let us know if you have any questions.

Background

Now we would like you to tell us how you evaluate, integrate, and implement learning technology into a program or course of instruction. We are interested in getting information about things like how you actually decide to use a specific technology, where you learn about

available technologies, how you think about technology in relation to learning outcomes, etc. Our end goal is to understand how you currently integrate technology with learning so that we help to make this process a bit more effective.

Questions

The questions listed below are intended to be reflective of a semi-structured interview approach; therefore, we may not ask all of these questions and, alternatively, we may ask additional ones.

1. *What kind of training do you specifically develop?*
2. *In the training you develop, are there any major training events or exercises? If so, are there specific technologies you use to support these events and exercises?*
3. *How frequently does training occur, and what drives this frequency?*
4. *Have you been a training developer and instructor?*
5. *What do you find helpful about using learning technologies?*
6. *To what extent does technology play a role in your training design plans? What determines this role?*
7. *Which technologies do you use and why? If you did not make the decision to use the technology, who is responsible for making this decision?*
8. *Do you collaborate with other training developers to make these decisions?*
9. *What are the advantages and disadvantages of the technologies you use?*
10. *What are the different methods (e.g., seminar, discussion), techniques (e.g., instructor led, computer-based, presentation, hands-on), and environments (e.g., classroom, field exercise) that you incorporate when you develop training, and what drives the decision to use that method?*
11. *How do you learn about the available technologies to use (is there a central database/resource center)?*
12. *Were you taught a formal process to incorporate technology or is this based on your experiences or a mentor's experiences?*
13. *Where would you insert a process for technology validation within the ADDIE process, and why?*
14. *How do you consider training and learning objectives in your decision to use a particular technology?*
15. *What factors drive the decision to use a particular technology?*

Survey Discussion

We will review your responses for each factor with the interviewee and possibly ask follow-up questions.

Recap and Conclude

- Summarize the interview and restate the high-level ideas we took away from the interview;
- Restate the goals of the interview and how the interview helped our efforts; and,
- Thank the interviewee again for his or her time and willingness to participate in the interview.

Appendix E-1

Learning Technology Specification Process Example

Learning Technology Specification Guidelines

(Entries for a notional example are included in italics.)

Instructions. First, think about the training objectives or desired learning outcomes that the training should achieve, and write them down in the space provided below. In addition, think about the training audience (e.g., rank, level of experience, relevant background information), and write down relevant information in the space provided below.

Training Objectives or Learning Outcomes

Demonstrate ability to employ "shift from a known point" method of conducting a fire mission.

Training Audience

Soldiers being trained in Forward Observer (FO) techniques. Altho the topic is addressed in the current FO POI, approx 10% of students need additional/remedial instruction, but there is no schedule "white space" in the POI for instructors to supply add'l training.

Step 1: Learning Requirements Matrix. Thinking about the training objectives or learning outcomes and the training audience listed above, read through each of the questions in the matrix, and circle the answer that best describes the training goals and learners. Then, in the Summary Table below list all of the items in the *Critical Learning Requirements* column that are circled in one of the first two columns in the matrix, and describe the ways in which learning technology may support the learning requirements in the *Technology Requirements* column.

Learning Requirements	**Once you have determined a critical learning requirement, think about how the requirement will be filled. Is technology needed, or is there another mechanism to help you meet the requirement?**		
What level is the training intended to promote?	The training involves higher order skills such as critical thinking, problem solving, and leadership	The training is oriented mostly toward procedures.	The training is oriented mostly toward declarative knowledge.
Will there be a need to exchange information remotely?	It is necessary for the training content to be published and learners to access and respond remotely to the training content.	It is necessary for the training content to be published and learners to have remote access to content.	No information needs to be exchanged remotely.
Is it necessary to provide informal feedback (e.g., comments on performance as progressing through training content)?	Informal feedback is critical to meeting the objectives of this training.	The learner must be able to request and receive informal feedback.	Informal feedback is not necessary given current objectives and training audience.
Is it necessary to provide formal feedback (e.g., tests and formal assessments)?	Formal feedback is critical to meeting the objectives of this training.	The learner must be able to request and receive formal feedback.	Formal feedback is not necessary given current objectives and training audience.

Will training that adapts to learner needs and knowledge states help to meet learning and training objectives?	Adaptive training is critical to meeting the objectives of this training.	Adaptive training may be necessary for some, but not all, training objectives.	Adaptive training is not necessary given current objectives and training audience.
Will immersive experiences help to meet learning and training objectives?	Embedding immersive experiences is critical to meeting the objectives of this training.	Immersive experiences may be necessary for some training objectives.	Immersive experiences are not necessary given current objectives and training audience.
Will opportunities for hands-on learning and exploration help to meet learning and training objectives?	Hands-on learning opportunities are critical to meeting the objectives of this training.	Hands-on learning may be necessary for some objectives but is not necessary.	Hands-on learning opportunities are not necessary given current objectives and training audience.
Will collaboration help to meet learning and training objectives?	Collaboration is critical to meeting the objectives of this training.	Collaboration may help promote some training objectives but is not necessary.	There is no need for collaboration among learners given current objectives and training audience.

SUMMARY TABLE

Critical Learning Requirements	**Technology Requirements**
Procedural training	*Must be able to train step-by-step procedures*
Informal feedback	*Learner must have informal (progress) feedback available during training*
Formal feedback	*Formal feedback ('success,' or informative listing of procedural errors at end of a training session) needed so learner can monitor mastery of the topic*

Step 2: Technology Capabilities Matrix. Thinking about the ways in which learning technology will support the critical learning requirements identified in Step 1, read through each of the questions in the matrix, and circle the answer that best describes the capabilities required of learning technology. Then, in the Summary Table below list all of the items in the *Critical Technology Capabilities* column that are circled in the matrix.

Technology Capabilities	**If technology is needed to help you meet the necessary learning requirements, think about the capabilities that the technology must possess.**		
Is there an anticipated need to edit or upgrade the technology?	The technology must be edited or upgraded often.	The technology will need to be edited or upgraded periodically.	The technology does not need to be edited or upgraded.
Will the technology need to be repurposed to support other content or instruction?	The technology must have the flexibility to be re-used or re-purposed. (Complete guidelines for that training/instruction if appropriate)	The technology may be available to support other content or instruction.	The technology can serve a single training/learning purpose.
Does the technology need to replace the instructor?	The technology must replace the instructor.	The technology must augment part of the instruction or support the instruction.	The technology does not need to replace the instructor.
Does the technology need to deliver instructional content?	The technology must serve as an instructional content delivery tool only.	The technology will be used to deliver instructional content and for other purposes.	The technology does not need to deliver instructional content; it will only be used for other purposes (e.g., assessing performance).

Does the technology need to support immersive training environments?	The technology must support immersive training.	The technology must augment an immersive environment	The technology does not need to support immersive environments.
Does the technology need to replicate a system (e.g., weapons system) or equipment?	It must match the system or equipment exactly.	The technology should replicate some but not all functions of the system or equipment but not match exactly.	The technology does not need to replicate a system or equipment.
Does the technology need to be high fidelity?	The technology must have high physical fidelity.	The technology must have high training/psychological fidelity.	Fidelity is not a concern.

Summary Table

Critical Technology Capabilities
Because call-for-fire procedures very rarely change, there is no reqmt that the technology be editable.
Altho the reqmt is to support 'shift from a known point,' support for other procedures is desirable, but not required.
The technology need not be stand-alone; it supports a procedure that the instructor has already covered in the classroom.
There is no reqmt to deliver instruction – the technology is intended primarily to support drill and practice.
There is no reqmt to support immersive training
There is a critical list of functions to be replicated that includes; • *"Intelligent" voice comms between learner and a fire direction function* • *Capability to represent target(s) and known point(s)* • *Capability to represent and determine azimuths between learner and (1) target(s) and (2) known point(s)* • *Capability to represent and estimate distances* • *Capability to represent munitions effects*
There is no need for high physical fidelity, but the fidelity must support training.

Step 3: Resources and Constraints Matrix. Thinking about the critical technology capabilities identified in Step 2, read through each of the questions in the matrix, and circle the answer that best describes the available resources and limited factors that affect the decisions to select and

implement learning technologies in training. The outcome should provide a list of requirements for choosing the most appropriate learning technology and emphasize the critical considerations when making selection decisions. The outcome may also be useful in trading off among the considerations.

Resources and Constraints	**What are the resources and constraints that enable or inhibit the use of technology? Thinking about the resources and constraints will let you understand if you are able to meet the critical requirements you determined in the other matrices.**		
Where is the training taking place?	In the institutional domain.	In the operational domain.	In the self-development domain.
What level of resources (e.g., bandwidth) or infrastructure required to implement a technology can be supported?	A high level of resources can be supported.	A medium level of resources can be supported.	A low level of resources can be supported.
Will there be time and resources available to train instructors on how to use the technology?	There will be resources available to provide training to the instructors on how to both operate and employ the technology.	There will only be resources available to train instructors on how to operate the technology	There will be no resources available to provide training to the instructors on how to use the technology.
What level of on-site support for instructors is available?	A high level of on-site support is available.	Some support is available on site.	Support is available only off-site.

How available must the technology be to the learner?	The technology needs to be always available to the learner.	The technology needs to be sometimes available to the learner, but the time at which it is available is flexible.	The technology can be available only during specified times.
Is the technology capable of self-power?	The technology is capable of providing its own power supply.	The technology is capable of providing its own power supply for a limited amount of time (e.g., after 8 hours of use) and must be re-charged.	The technology is not capable of self-power and requires an external power source.
Does the technology need to be portable?	The technology needs to be used in a variety of environments or areas.	The technology needs to support both a traditional classroom as well as other environments.	The technology has no portability requirements.
Where will technical development be conducted?	Technical development can be conducted in-house.	Technical development must be outsourced, but within another military organization.	Technical development will be performed by a second or third-party developer (i.e., contractor).
What is the level of management/organizational support to use the technology?	There is a high level of management/ organizational support.	There is a moderate level of management/ organizational support.	There is a low level of management/ organizational support.

What is the class size?	The class size is large (greater than 30 learners).	The class size is medium (20 to 30 learners).	The class size is small (less than 20 learners).
What is the development timeline (from decision to implementation) for the technology to be implemented in training?	The technology is required within 6 months.	The technology is required within 18 months.	The technology is required in 18-24 months (or longer).
What is the available budget?	There is a large budget available for technology.	There are some budgetary constraints, but not too much to be concerned with.	There is a small budget available for technology.

Summary Table

Resources and Constraints
The technology will support self-study, and, thus, even though it cannot require a high level of resources to support it, it must have high availability to support 'any time' training
Because the technology will support supplemental training, it cannot be resource intensive; resources must be concentrated on the core course.
No resources will be available to instruct instructors in the use of the technology.
Depending on the technology selected, the schoolhouse may be able to provide some, but not all the needed technical support
The technology must be self-sufficient (e.g. self-powered) and usable outside the classroom
Most likely the technology must be developed by an outside 3rd party
Due to budget considerations, management/organizational support for the technology project will be at most moderate.
If the technology involves individual hardware for individual students, a quantity of units sufficient to serve approx 10% of a class of 30 students must be procured.
This is in support of a current training gap; the technology solution is required within 6 months (preferably less).
There is only a small budget available for developing and then maintaining technology for this requirement.

Summary Considerations

Budget appears to be a major constraint. With that in mind, what would be the impact of:
• *Changing from asynchronous to synchronous instruction delivered outside the classroom. With an average of 3 students per class needing the supplemental drill, coordination of a set instructional time each day outside the classroom might be acceptable.*
• *Eliminating either the formal feedback reqmt or the informal feedback reqmt*
• *Extending the required delivery date to a year or maybe 18 months?*
• *Meeting the reqmt using currently available in-house technology?*

Appendix E-2

Learning Technology Specification Process Template

Learning Technology Specification Guidelines

Instructions. First, think about the training objectives or desired learning outcomes that the training should achieve, and write them down in the space provided below. In addition, think about the training audience (e.g., rank, level of experience, relevant background information), and write down relevant information in the space provided below.

Training Objectives or Learning Outcomes

Training Audience

Step 1: Learning Requirements Matrix. Thinking about the training objectives or learning outcomes and the training audience listed above, read through each of the questions in the matrix, and circle the answer that best describes the training goals and learners. Then, in the Summary Table below list all of the items in the *Critical Learning Requirements* column that are circled in one of the first two columns in the matrix, and describe the ways in which learning technology may support the learning requirements in the *Technology Requirements* column.

Learning Requirements	**Once you have determined a critical learning requirement, think about how the requirement will be filled. Is technology needed, or is there another mechanism to help you meet the requirement?**		
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Will collaboration help to meet learning and training objectives?	Collaboration is critical to meeting the objectives of this training.	Collaboration may help promote some training objectives but is not necessary.	There is no need for collaboration among learners given current objectives and training audience.

SUMMARY TABLE

Critical Learning Requirements	Technology Requirements

Step 2: Technology Capabilities Matrix. Thinking about the ways in which learning technology will support the critical learning requirements identified in Step 1, read through each of the questions in the matrix, and circle the answer that best describes the capabilities required of learning technology. Then, in the Summary Table below list all of the items in the *Critical Technology Capabilities* column that are circled in the matrix.

Technology Capabilities	**If technology is needed to help you meet the necessary learning requirements, think about the capabilities that the technology must possess.**		
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Does the technology need to deliver instructional content?	The technology must serve as an instructional content delivery tool only.	The technology will be used to deliver instructional content and for other purposes.	The technology does not need to deliver instructional content; it will only be used for other purposes (e.g., assessing performance).

Does the technology need to support immersive training environments?	The technology must support immersive training.	The technology must augment an immersive environment.	The technology does not need to support immersive environments.
Does the technology need to replicate a system (e.g., weapons system) or equipment?	It must match the system or equipment exactly.	The technology should replicate some but not all functions of the system or equipment but not match exactly.	The technology does not need to replicate a system or equipment.
Does the technology need to be high fidelity?	The technology must have high physical fidelity.	The technology must have high training/psychological fidelity.	Fidelity is not a concern.

Summary Table

Critical Technology Capabilities

Step 3: Resources and Constraints Matrix. Thinking about the critical technology capabilities identified in Step 2, read through each of the questions in the matrix, and circle the answer that best describes the available resources and limited factors that affect the decisions to select and implement learning technologies in training. The outcome should provide a list of requirements for choosing the most appropriate learning technology and emphasize the critical considerations when making selection decisions. The outcome may also be useful in trading off among the considerations.

Resources and Constraints	What are the resources and constraints that enable or inhibit the use of technology? Thinking about the resources and constraints will let you understand if you are able to meet the critical requirements you determined in the other matrices.		
Where is the training taking place?	In the institutional domain.	In the operational domain.	In the self-development domain.
What level of resources (e.g., bandwidth) or infrastructure required to implement a technology can be supported?	A high level of resources can be supported.	A medium level of resources can be supported.	A low level of resources can be supported.
Will there be time and resources available to train instructors on how to use the technology?	There will be resources available to provide training to the instructors on how to both operate and employ the technology.	There will only be resources available to train instructors on how to operate the technology	There will be no resources available to provide training to the instructors on how to use the technology.
What level of on-site support for instructors is available?	A high level of on-site support is available.	Some support is available on site.	Support is available only off-site.

How available must the technology be to the learner?	The technology needs to be always available to the learner.	The technology needs to be sometimes available to the learner, but the time at which it is available is flexible.	The technology can be available only during specified times.
Is the technology capable of self-power?	The technology is capable of providing its own power supply.	The technology is capable of providing its own power supply for a limited amount of time (e.g., after 8 hours of use) and must be re-charged.	The technology is not capable of self-power and requires an external power source.
Does the technology need to be portable?	The technology needs to be used in a variety of environments or areas.	The technology needs to support both a traditional classroom as well as other environments.	The technology has no portability requirements.
Where will technical development be conducted?	Technical development can be conducted in-house.	Technical development must be outsourced, but within another military organization.	Technical development will be performed by a second or third-party developer (i.e., contractor).
What is the level of management/organizational support to use the technology?	There is a high level of management/ organizational support.	There is a moderate level of management/ organizational support.	There is a low level of management/ organizational support.

What is the class size?	The class size is large (greater than 30 learners).	The class size is medium (20 to 30 learners).	The class size is small (less than 20 learners).
What is the development timeline (from decision to implementation) for the technology to be implemented in training?	The technology is required within 6 months.	The technology is required within 18 months.	The technology is required in 18-24 months (or longer).
What is the available budget?	There is a large budget available for technology.	There are some budgetary constraints, but not too much to be concerned with.	There is a small budget available for technology.

Summary Table

Resources and Constraints

Summary Considerations

Appendix F

Course Outline in a Draft Training Support Package

Learning Technology Specification Process

Lesson Plan

SEPTEMBER 2013
Module 001 - Lesson 1

SECTION I. ADMINISTRATIVE DATA

All Courses Including This Lesson	**<u>Course Number</u>** **<u>Version</u>** **<u>Course Title</u>** TBD Lesson 1 Learning Technology Specification Process
Task(s) Taught(*) or Supported	<u>Collective Task</u> <u>Task Number</u> None TBD <u>Individual Task</u> <u>Task Number</u> TBD TBD TBD TBD TBD TBD
Reinforced Task(s)	**<u>Task Number</u>** **<u>Task Title</u>** TBD
Academic Hours	The academic hours required to teach this lesson are as follows: **Resident** **<u>Hours/Methods</u>** 1 hrs / CO Test 0 hrs Test Review 0 hrs Total Hours: 1 hrs
Test Lesson Number	**<u>Hours</u>** **<u>Lesson No.</u>** Tested as part of the Module 1 Test.
Prerequisite Lesson(s)	**<u>Lesson Number</u>** **<u>Lesson Title</u>** None N/A Students are required to have an understanding of each phase of the ADDIE process.
Security Clearance /Access	Requirements: Instructor will at the start of each lesson, inform students as to the classification of the material to be covered. Students are not required to have a security clearance for this material.
Foreign Disclosure Restrictions	FD TBD. This product <u>*should be*</u> releasable to students from foreign countries.
References	

Number	**Title**	**Date**	**Additional Information**
	Learning Technology Specification: Principles for Army Training Designers and Developers. ARI Project # ______	4/1/13	

Student Study Assignments	None

Instructor Requirements	1 Primary Instructor (PI)

Additional Support Personnel Requirements

Name	Stu Ratio	Qty	Man Hours
None			

Equipment Required for Instruction

ID Name	Stu Ratio	Instr Ratio	Spt	Qty	Exp
None					

Materials Required

Instructor Materials:

Lesson plan, computer, projector, lesson material, student handouts, and classroom signs.

Student Materials:

None

Classroom, Training Area, and Range Requirements

Instruction BLDG, 15 Person Capacity w/proper support facilities/break area, Instructor facilities with proper support equipment for instruction, proper seating arrangements, lighting, and ventilation, work space, map board space, white board.

Ammunition Requirements

Id	Name	Exp	Stu Ratio	Instr Ratio	Spt Qty
None					

Instructional Guidance

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

SPECIFIC PREPARATORY INSTRUCTIONS

A. PRIOR TO INSTRUCTION

1. Make proper preparation for instruction, using all available reference material.
2. Report to classroom 30 minutes prior to start of class. (USAADASCH REG 350-8).
3. Check personal appearance.
4. Insert classroom signs in racks at front of classroom in the following order shown.

    Course: TBD

    Title: **Learning Technology Specification**

    Instructor: TBD

    Security Classification: UNCLASSIFIED

5. Post “Class in Session” sign outside classroom.
6. Police classroom or trainer.
7. Energize, warm up, and check out equipment. Ensure that computers and projection equipment work and current instructional material is loaded.
8. Ensure that all equipment needed, as specified in the Lesson Plan, is available.
9. Check on seating arrangement, lighting, and ventilation.

10. Check proper display of instructional material in classroom or trainer (computers, overhead projectors, TV display units, etc.).
11. Ensure that the visitor's information folder is at the rear of the room. The visitor's folder will contain the lesson plan and any student handouts. Each instructor will be responsible for placing the folder on a chair or desk at the rear of the classroom beginning instruction. The Primary Instructor (PI) is responsible for making the visitor's folder available during practical exercises or when a class is divided into small groups (USAADASCH REG 350-8).
12. Check on Assistant Instructors when scheduled.
13. Check availability and operational condition of all training aids, systems, tools, and test equipment listed in the lesson plan or instruction sheet.
14. Have class-seating plan to include student name and location in classroom.
15. Study fire evacuation plan for classroom.

B. DURING INSTRUCTION

1. Ensure that each student has materials needed for the lesson/exercise.
2. Explain objectives of lessons, reasons for learning, and tie-in. Present each unit as a part of a whole.
3. Inform class of any changes or corrections to student reference material.
4. Observe attentiveness, attitude, and adaptability, especially of those students whose grades are below average.
5. Follow the lesson plan in conference and practical exercise (PE).
6. Be aware of and identify class reactions and maintain discipline, such as no talking or sleeping during class.
7. Question students frequently to check their understanding and to keep the class alert; recognize correct answers; correct wrong ones.
8. Supervise, as appropriate, all PE work and ensure that students remain involved with problems throughout the period.
9. Give students equal time on equipment in the PE.
10. Assistant Instructors will report unusual incidents to the PI.
11. Announce and enforce the no eating, drinking, or smoking rules in the classroom.
12. Keep extraneous material out of the classroom.
13. Primary Instructor will ensure that the exercises being conducted by PE instructors are scheduled in accordance with (IAW) established policy.

C. AFTER INSTRUCTION

1. Ensure proper police of classroom and other areas used by the students.
2. Ensure that no classified material is left in the classroom, trainer, or equipment.
3. Check classroom to insure whiteboards are clean, lights off, signs removed, secure classroom, and secure equipment.

Proponent Lesson Plan Approvals	**Name**	**Rank**	**Position**	**Date**
	TBD			

SECTION II. INTRODUCTION

Method of Instruction: CO

Instructor to Student Ratio is: 1:15

Time of Instruction: 3 hr (includes 30min PE)

Media: TD

Motivator

ATTENTION STEP:

The Army Learning Concept for 2015, TP 525-8-2, Change 1, states that "It (the concept) seeks to improve our learning model by leveraging technology without sacrificing standards so we can provide credible, rigorous, and relevant training and education for our force of combat-seasoned Soldiers and leaders."

NOTE:

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you the student will:

Action:	**Implement the Learning Technology Specification Process**
Conditions:	**In a classroom environment**
Standards:	**The Student implements the process to determine appropriate technologies to conduct instruction, IAW the following reference _________**

Safety Requirements

Classroom: Prior to classroom instruction, instructor will remind students of safety precautions to be taken while in the classroom. For example:

* Do not lean back in chairs.

* Do not trip over raised floor platforms.

* Watch for electrical cords.

* Do not trip over doorway threshold.

Risk Assessment Level

Low

Environmental Considerations

NOTE: It is the responsibility of all Soldiers and DA civilians to protect the environment from damage.

None

Evaluation

At the end of the lesson, you will be given a practical exercise. There is no evaluation or test.

Instructional Lead-In

A. ***TIE-IN:** In this lesson, we will examine how the Learning Technology Specification Process aides training designers and developers to evaluate instructional technology. The Learning Technology Specification process includes principled and scientifically-based guidelines. It requires the user to think critically about the learning requirements based on the training objectives and required learning technology capabilities to support learning.

B. **CONDUCT OF THE CLASS:** I am XXXX. I will be your primary instructor during this two and one half hours class on the Learning Technology Specification Process. This class will be conducted as lecture and a discussion. I encourage you to participate in an open dialog through the instruction.

SECTION III. PRESENTATION

NOTE: Inform the students of the Enabling Learning Objective requirements.

A. ENABLING LEARNING OBJECTIVE

ACTION:	**Explain the Learning Technology Specification Process**
CONDITIONS:	**In a classroom environment**
STANDARDS:	**The student will demonstrate knowledge of how the Learning Technology Specification Process fits within the ADDIE process.**

1. Learning Step / Activity 1: **Describe the Learning Technology Specification Process**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 10 minutes

Media: TD

Security Classification: Unclassified

A. The purpose of the Learning Technology Specification Process is to determine which capabilities are required of learning technology to best meet your training goals based on your training objectives.

B. The Learning Technology Process fits within the Design phase of ADDIE.

C. The process comprises of three steps: 1) the Learning Requirements Matrix, 2) the Technology Capabilities Matrix, and 3) the Resources and Constraints Matrix.

B. ENABLING LEARNING OBJECTIVE

ACTION:	**Complete the Learning Requirements Matrix**
CONDITIONS:	**In a classroom environment**
STANDARDS:	**The student will demonstrate knowledge on the use of the Learning Requirements Matrix**

1. Learning Step / Activity 1: **Complete the Learning Requirements**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Learning Requirements are defined as how the learning will be promoted (e.g. training goals, types of learning experiences, and types of feedback needed).

B. Identify which requirements are most important to your training goals/objectives.

2. Learning Step / Activity 2 **Describe how the user navigates the Learning Requirements matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Review the Learning Requirements down the left hand column of the matrix.

B. For each question, read the three possible selections that relate to that question.

C. Take time to think through each of the three possible selections.

D. Identify which are the most important factors in the technology in relation to the question.

E. Circle the box that fits best.

3. Learning Step / Activity 3: **Describe the questions and possible selections within the matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 30 minutes

Media: TD

Security Classification: Unclassified

A. Each question is meant to provoke thought in a specific area.

B. Each selection helps you to think crucially about the answer to the question.

C. Review the questions and possible sections to explain their meaning or definition.

C. ENABLING LEARNING OBJECTIVE

ACTION:	**Complete the Technology Capabilities Matrix**
CONDITIONS:	**In a classroom environment**
STANDARDS:	**The student will demonstrate knowledge on the use of the Technology Capabilities Matrix**

1. Learning Step / Activity 1: **Describe the Technology Capabilities**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Technology Capabilities are defined as the physical aspects of the technology that support learning.

B. Determine which capabilities are most important to your training goals/objectives.

2. Learning Step / Activity 2 **Describe how the user navigates the Technology Capabilities matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Review the Technology Capabilities down the left hand column of the matrix.

B. For each question, read the three possible selections that relate to that question.

C. Take time to think through each of the three possible selections.

D. Decide which are the most important factors in the technology in relation to the question.

E. Circle the box that fits best.

3. Learning Step / Activity 3: **Describe the questions and possible selections within the matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 30 minutes

Media: TD

Security Classification: Unclassified

A. Each question is meant to provoke thought in a specific area.

B. Each selection helps you to think crucially about the answer to the question.

C. Review the questions and possible sections to explain their meaning or definition.

D. ENABLING LEARNING OBJECTIVE

ACTION:	**Complete the Resources and Constraints Matrix**
CONDITIONS:	**In a classroom environment**
STANDARDS:	**The student will demonstrate knowledge on the use of the Resources and Constraints Matrix**

1. Learning Step / Activity 1: **Describe the Resources and Constraints Matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Resources and Constraints should be one of your last considerations, but a very important consideration.

B. Resources and Constraints are defined as restrictions related to implementing technology (e.g. available budget, size of class, infrastructure requirements, and the learning environment).

2. Learning Step / Activity 2: D**escribe how the user navigates the Resources and Constraints Matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 5 minutes

Media: TD

Security Classification: Unclassified

A. Review the Resources and Constraints down the left hand column of the matrix.

B. For each question, read the three possible selections that relate to that question.

C. Take time to think through each of the three possible selections.

D. Select the most important factors in the technology in relation to the question.

E. Circle the box that fits best.

3. Learning Step / Activity 3: **Describe the questions and possible selections within the matrix**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 30 minutes

Media: TD

Security Classification: Unclassified

A. Each question is meant to provoke thought in a specific area.

B. Each selection helps you to think crucially about the answer to the question.

C. Review the questions and possible sections to explain their meaning or definition.

E. ENABLING LEARNING OBJECTIVE

ACTION:	**Analyze your results from the three matrices**
CONDITIONS:	**In a classroom environment**
STANDARDS:	**The student will demonstrate knowledge on reviewing the results, analyzing them, and making a selection**

1. Learning Step / Activity 1: **Describe the analysis of results process**

Method of Instruction: CO

Instructor to Student Ratio: 1:15

Time of Instruction: 15 minutes

Media: TD

Security Classification: Unclassified

A. Review the selected answers in each of the three matrices.

B. Record your overall thoughts and results.

C. Specify the most appropriate technology based on the requirements determined by reviewing the learning technology process matrices.

SECTION IV. SUMMARY

A. The Learning Technology Specification Process can be used for new course development or to improve a current course of instruction.

B. The process generates discussion and thought about the best learning technology to support training objectives.

C. The user must have the products developed in the Analysis phase of ADDIE to be successful.

Method of Instruction: CO
Instructor to Student Ratio is: 1:15
Time of Instruction: 5 minute
Media: TD

Check on Learning	Determine if the students have learned the material presented by soliciting student questions and explanations. Ask the students questions and correct misunderstandings.
Review / Summarize Lesson	This lesson has provided you with an explanation of the Learning Technology Specification Process. This process should be considered when determining the best technology to integrate into a course of instruction based on your training goals and training objectives.
Transition to Practical Exercise	Next you will complete a practical exercise to provide hands-on use of the Learning Technology Specification Process

SECTION V. STUDENT EVALUATION

Testing Requirements	**N/A**
Feedback Requirements	**Check on Learning**

Practical Exercises Sheet

Title	**Learning Technology Specification Process**
Intro-duction	**You will now take a fictional Enabling Learning Objective (ELO) from a course of instruction through the Learning Technology Specification Process.**
Motivator	
TLO, ELO, or Learning Step/Activity	[If PE sheet is used by student: **list** the TLO, ELO, or learning step the PE covers. If instructor-led: **inform** the students of the TLO, ELO, or learning step the PE covers.] **Use the Learning Technology Specification Process to determine the learning technology requirements and select a learning technology to implement in a course of instruction based on these requirements.**
Safety Require-ments	None
Risk Assessment	Low
Environmental Consider-ations	None.
Evaluation	None. This is a familiarization practical exercise.
Instructional Lead In	This practical exercise will provide further familiarization to the Learning Technology Specification Process and serve as a supplement the instruction you just received. You will receive a training goal, training objectives, and other information developed during the Analysis phase of ADDIE. Your goal is to determine learning technology capabilities that best support the training objectives and to find a learning technology based on these capabilities.

Resource Require-ments	Practical Exercise scenario and supplemental information from ADDIE process.
Special Instructions	Collaboration is encouraged.

Procedures

1. Instructor describes the practical exercise.

2. Instructor provides hand-outs to the students (PE and reference material).

3. Students form groups or work alone.

4. Students review the reference material prior to using the Learning Technology Process.

5. Students begin with Learning Requirements Matrix to select the appropriate technology category and record their results.

6. Students move to the Technology Capabilities Matrix to select the appropriate technology category and record their results.

7. Students finish with the Resources and Constraints Matrix to select the appropriate technology category and record their results.

8. Students consider their results and discuss among their group (if in a group).

9. Students select a learning technology based on the set of requirements uncovered by reviewing the three matrices.

10. Instructor reviews the results among the class. Facilitates discussion on why a student or group of students made their decisions or choices.

11. Instructor picks up practical exercise material, leaving the students with a copy of the Learning Technology Process.

Feedback Require-ments

Instructor should record feedback on the practical exercise and provide to the proponent for this lesson.